Heating Piping & Air Conditioning

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NOVEMBER ★ 1946

INDUSTRIAL
COMMERCIAL
INSTITUTIONAL AND
PUBLIC BUILDINGS

103—Journal Section of the American Society of Heating and Ventilating Engineers

The "inside story" of the heating system design for a new product development and testing laboratory is given this month

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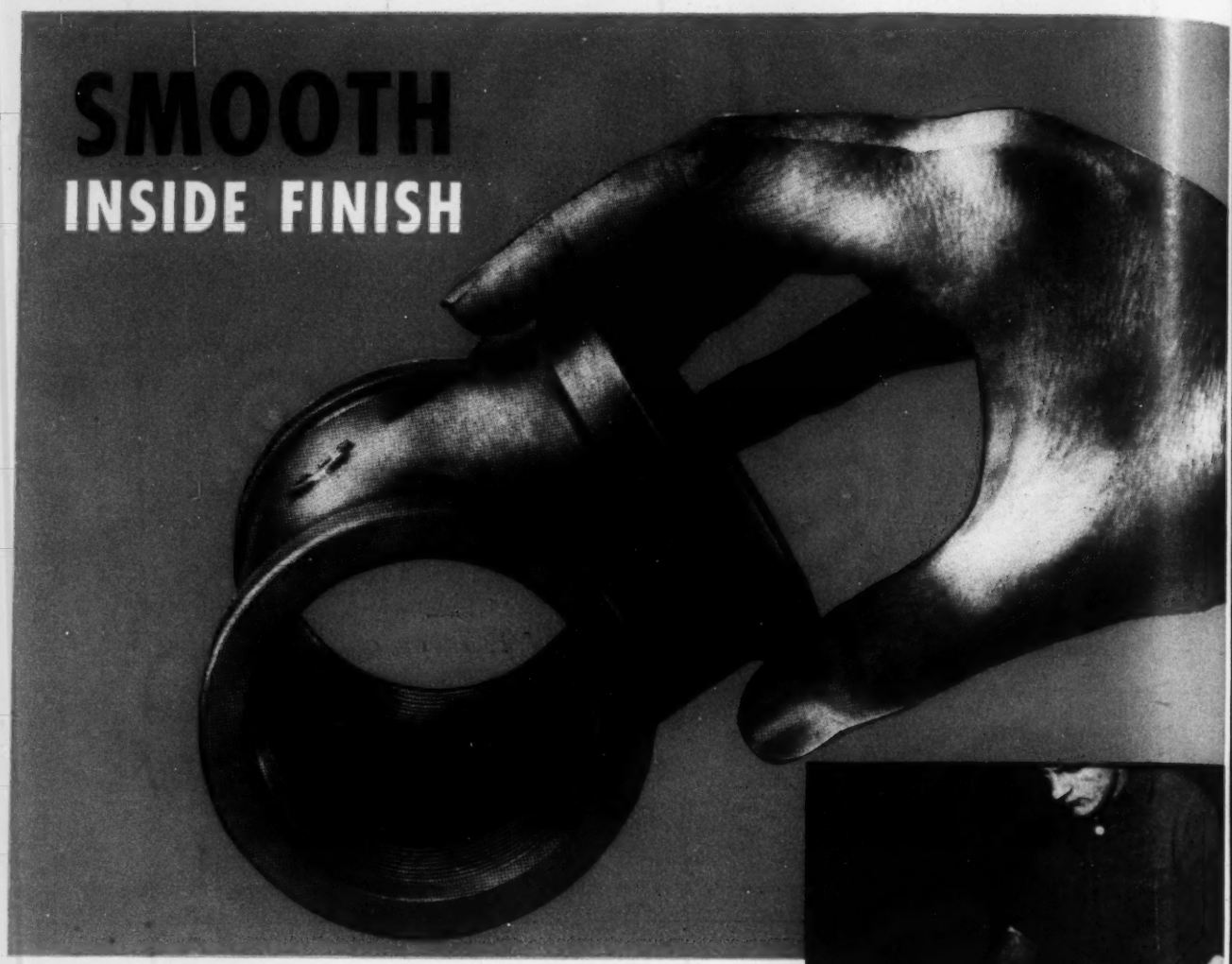
SMOOTH INSIDE FINISH



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THE EDITOR'S PAGES

EFRIGERANT DATA EFERENCES GIVEN

Publication is completed this nonth of an extensive series of tables iving comparative engineering data n various refrigerants. Those pre-ented in this issue cover "Freon-11," nd there are tables for theoretical apacity of refrigerating compres-ors, volume of refrigerant to be com-ressed, weight of refrigerant to be irculated, theoretical horsepower per ubic foot per minute of vapor com-ressed, and theoretical horsepower f refrigerating compressors.

Similar information on other re-rigerants was given in the following ssues of HPAC:

Ammonia — August 1944, pages 478-480.

"Freon-12" — August 1946, pages 91-93.

"Freon-21" — March 1946, pages 91-93.

"Freon-22" — June 1944, pages 337-338; July 1944, page 409; December 1945, pages 616-618.

"Freon-113" — May 1946, pages 83-85.

Methyl chloride — May 1945, pages 256-258.

Water vapor — October 1944, pages 593-594.

At the present writing, it is impossible for HPAC to furnish complete copies of these tables, although they may be reprinted at some future date. The above listing is given for convenient reference to back issues for those who preserve their copies of HPAC intact or who may want to refer to them in libraries.

BIG FUEL SAVING POSSIBLE, SAYS INSULATION AUTHORITY

America wastes 700 man-years of labor annually in the primary work of mining coal from which the heat and power is wasted, according to Robert E. Outman of the United States Mineral Wool Co., and president and chairman of the board of the Industrial Mineral Wool Institute, at the institute's recent fall meeting.

His figure is based on the manpower necessary to mine more than 10 million tons of coal which he says could be saved if the hot surfaces of pipes, boilers, flanges, and fittings were insulated to prevent avoidable heat loss. This estimate is exclusive of the labor expended in the refining of more than 15 million barrels of oil similarly wasted, and in the processing and transporting of a total of nearly 13½ million tons of fuel (representing an estimated 3 per cent loss by radiation of the fuels burned for industrial purposes).

Mr. Outman points out that the enormous drain of war on our national resources emphasizes the need for economy in times of peace. "Every industrial plant in the country", says Mr. Outman, "should be studied to locate the opportunities which exist to make immediate savings of 1 to 15 per cent in heat losses."

"MAKE IT TERSE AND TRITE"

J. M. Cleary, vice president of Roche, Williams & Cleary, Inc., and a member of the Committee for Economic Development's national information committee, presided at a meeting last month in Chicago at which the present objectives and methods of the CED were explained to a group of business press representatives. In his introductory remarks, he recalled a sales manager for whom he wrote advertising copy many years ago and whose instructions were invariably "Make it terse and trite."

Terse but far from trite were the explanations that followed of the CED's business press program, research program, and information committee program.

The CED was organized in September 1942 and at that time it undertook two activities. One was to help businessmen lay plans for quick reconversion and expanded production, distribution, and employment after victory. Such plans, of course, needed to be made plant-by-plant and community-by-community, for jobs are created by individual businesses at the grass roots.

The other major original purpose of the CED was objective research to develop recommendations for those economic policies which would encourage both the *attainment* and the *maintenance* of high productive employment. This assignment has not been completed.

In the war years the research studies were concerned largely with the problems of *attaining* high production and employment in the transition. Obviously, it was not enough that individual businessmen plan boldly for expanded production and employment. Putting the plans to work required a favorable economic climate; it was necessary that government and private policies facilitate the new enterprises that were planned and the expansions of existing enterprises.

CED research from the beginning also has been concerned with the longer range problems of maintaining high employment and production. Already completed are studies by economists and statements on national policy on principles of a tax system to encourage high production and employment; on policies to promote high farm production and real income; and on international trade policies which will improve employment opportunities and raise living standards here and elsewhere. Fifteen or more additional studies are in prospect for the future. Several of these are under way. All are directed toward finding ways of making the economy more stable while keeping it dynamic; of achieving and maintaining a high level of employment and productivity.

Watch for the special "SHOW SECTION" in HPAC next month

SPECIALIZES IN MODERNIZATION

Announcement was made last month of the establishment of Andre Merle Associates, architectural engineers, with offices in the Southern Bldg., Washington 5, D. C. The firm will specialize in modernization work, and will handle engineering design, detailing, specifications, and cost analysis for air conditioning, heating, ventilating, plumbing, and commercial refrigerating systems.

Mr. Merle — now out of military service — was the author of three articles on air conditioning installations at Rockefeller Center, published in HPAC in 1933 and 1934.

THE EDITOR'S PAGES

GAS PIPE LINE FLOW TO BE STUDIED

A research program "of no mean proportions, requiring many months of work and a considerable expenditure of money" is contemplated in a cooperative agreement negotiated by the American Gas Association with the Bureau of Mines, according to a report of the AGA's pipe line flow subcommittee, of which C. H. M. Burnham is chairman.

There are probably as many as 15 different high pressure flow formulas in use today, says the report, and it is proposed to examine and compare them as the first phase of the program. The second part of the work involves a study of fundamentals in the laboratory and on comparatively short sections of pipe lines, which will be followed by field studies on long pipe line systems. The final phase will be correlation of the data and development of conclusions.

This program is expected to involve spending some $67,000 over a period of four years.

PROMOTES BASIC BUILDING CODE

The Building Officials Conference of America, Inc. (whose temporary address is room 22A, 18 E. 48th St., New York 17), composed of municipal building officials charged with administration of building codes, laws, and regulations, established the Building Officials Foundation at the 31st annual meeting of the conference held in Memphis early last month.

Among the principal functions of the foundation are:

1) To encourage the adoption of the basic building code promulgated by the Building Officials Conference of America, Inc., by all communities, to the end that a countrywide uniform code be established and to encourage communities to keep their local codes up to date.

2) To assist communities in the administration of their building laws and regulations.

3) To reconcile local building codes with advances in the art of building to the end that structural design, equipment, construction materials, and methods may be progressively improved in the public interest.

4) To provide uniform testing procedure in consultation with industry in determining the adequacy of testing equipment, and for the evaluation of the integrity of equipment, materials and methods of construction.

"SEEMS TO BE A DIFFERENCE OF OPINION"

The city council of Toledo, Ohio, has passed the smoke abatement ordinance prepared for it by the Coal Producers Committee for Smoke Abatement, H. B. Lammers, director of engineering of the committee, announced last month. The ordinance was written after the organization had made a comprehensive survey of Toledo to determine causes and sources of smoke in that city.

In explaining the action of the council, Mr. Lammers said that "for all practical purposes Toledo has had an 'unofficial St. Louis ordinance' for years. More than 85 per cent of the domestic consumers in Toledo burn low volatile coal or coke. St. Louis bases its claims to a 'miracle' of smoke abatement on the fact that it made the people of lower income brackets — those who were unable to afford mechanical coal burning equipment— use high priced low volatile coal and said that the domestic consumer in St. Louis was responsible for 70 per cent of the smoke. If this contention is correct, there would have never been any smoke problem in Toledo."

ANNOUNCES TWO-FOLD PUBLIC RELATIONS PROGRAM

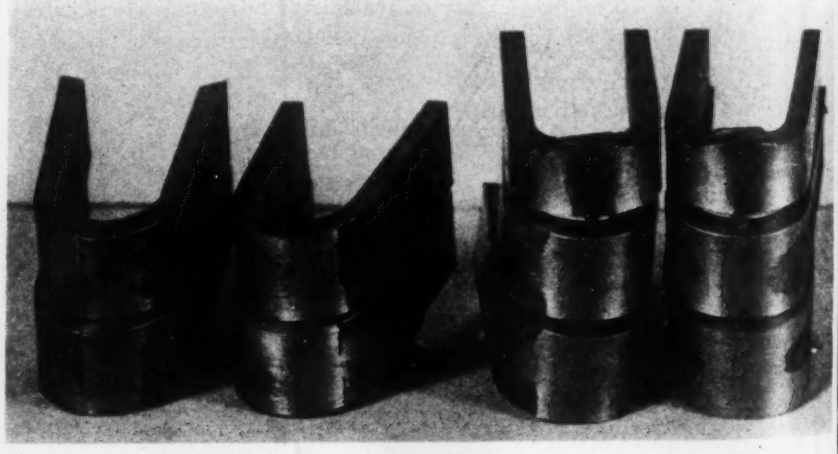
Public relations of the heating and plumbing industries will cover a two-fold program during 1947, it was announced at the 27th annual meeting of the Plumbing and Heating Industries Bureau. Because of the critical housing situation, the bureau will divide its attention between an educational program to acquaint the public with production difficulties in addition to its already established publicity program on the selection and installation of equipment.

EDITOR STICKS HIS NECK OUT

HPAC's editor stuck his neck out last month and gave a talk before the ASHVE's Wisconsin chapter on planning and producing the editorial content of a magazine such as this one. In his remarks, he dwelt at some length on the many precautions taken to avoid errors in both the text and the illustrations.

You might know it would happen. At the bottom of the second column of page 68 of the October issue, it is said that "typical weld bend test bars in 1.00 per cent chromium —½ per cent molybdenum steel that are required for qualification are shown in one of the illustrations." . . . but the picture wasn't published. Here it is this month. The bars indicate the ductility of the weld metal and thoroughness of root and side wall fusion.

Typical bend bars of welds made in 1.00 per cent chromium —½ per cent molybdenum steel



Home of Girard Trust Carries on Fine Tradition

GIRARD TRUST COMPANY GROUP OF BUILDINGS, PHILA., PA. Left to right: Morris Building, Girard Trust Co. Building, Girard Trust Office Bldg.

One of the first trust companies in America, organized in 1836 and never merged with any other bank, is the Girard Trust Company.

Carefully conservative in the Girard tradition is the management of the three Girard Trust properties in downtown Philadelphia. Their use of Webster Steam Heating Equipment, goes back to 1910... has kept these properties at the peak in comfort and economy in heating. The 28-story Girard Trust Office Building, the 18-story Morris Building, and the picturesque domed Girard Trust Company Building are today heated from one central boiler plant, with most of the installation enjoying the "controlled-by-the-weather" comfort of a Webster Moderator System.

In 1910, the first installation of Webster Heating Equipment was made in the Morris Building, when the engineering firm of Francis Brothers & Jellett, Inc. (now Stewart A. Jellett Co.) handled the installation of a "Webster System of Steam Circulation and Apparatus."

The Girard Trust Company Building has used Webster Heating Equipment since 1922, when Webster Traps were installed on direct radiation and on vento coils by W. G. Cornell Co., heating contractor.

In 1931, the 28-story Girard Trust Office Building was built and equipped with the Webster Sylphon Traps and Type W Valves. William H. Walters & Sons, Philadelphia, were the heating contractors and Tenney & Ohmes, Inc., New York, consulting engineers.

Webster Heating Equipment has been purchased at intervals for 35 years as made necessary by the changing requirements of these three buildings. Most recent improvement was the selection of a Webster Electronic Moderator System as part of a modernization program begun in 1945 involving a tailor-made orificing job—equipping 734 Radiator Supply Valves with properly sized Webster Metering Orifices. William H. Walters & Sons were the contractors and Moody & Hutchison, Philadelphia, consulting engineers.

Karl Rugart, Philadelphia Representative with Webster for 29 years, has worked closely with the operating personnel of the Girard properties to assure heating comfort, economy and ease of operation. Clarence Morris is Operating Engineer. Warren Moore is Superintendent. S. H. Bigler is Building Manager.

We are ready to work with you as we have worked with the Girard Trust Company.

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Webster
HEATING SYSTEMS

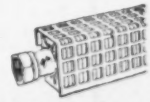
Webster Heating Equipment for Today's New Buildings

Webster Metering Orifices, expertly sized, a vital feature of the Moderator System, balance distribution and make possible central control with continuous heating.

Webster Outdoor Thermostat Control automatically provides the lowest pressure for comfortable inside temperature.

Webster Electronic Moderator Control Cabinet provides continuous heating, always under control.

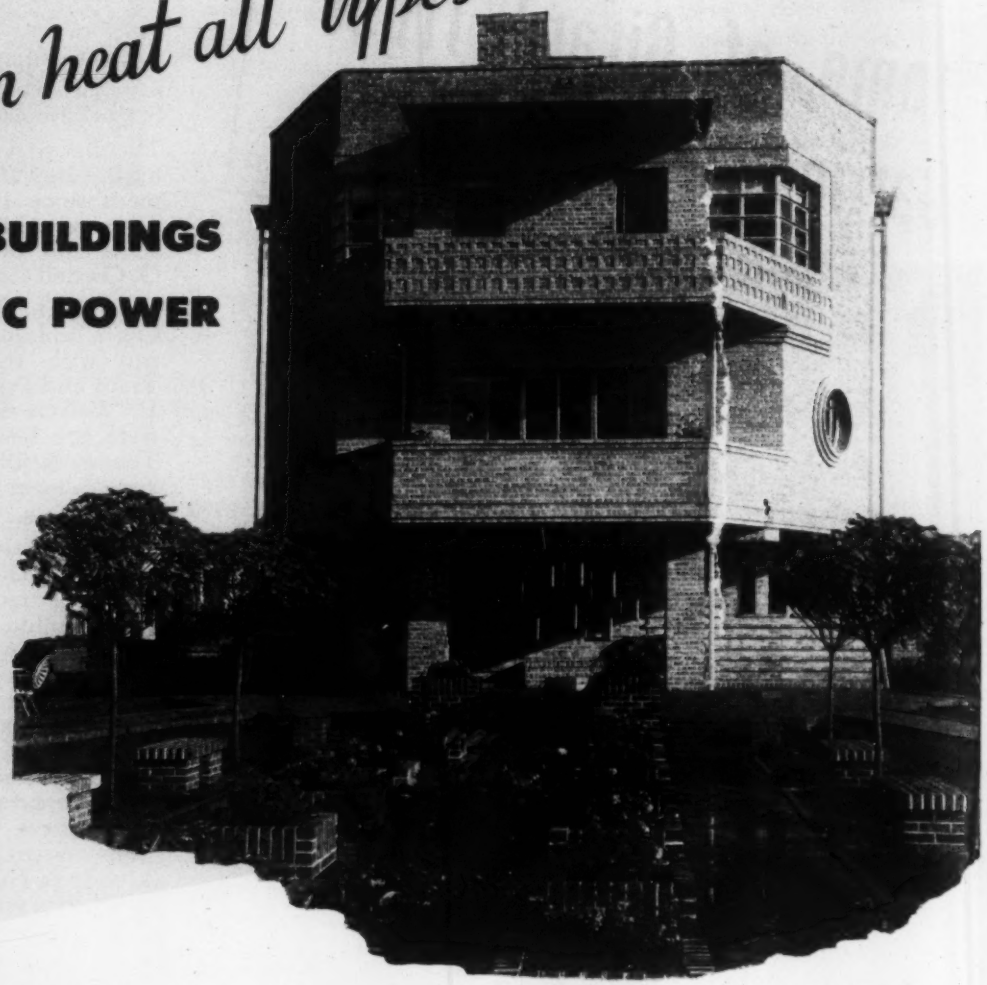
1946 Webster System Radiation—concealed convectors made of copper tubing and aluminum fins, with *integral* Webster Traps and Valves.



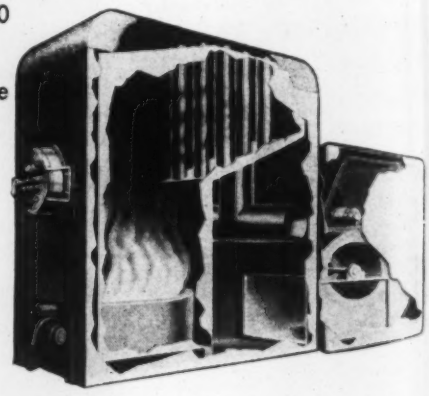
New! Webster Type WI Radiation for installation where floor or wall space is limited.

You can heat all types

OF BUILDINGS WITH J&C POWER HEATERS



Tomorrow, new apartment dwellings, like the one illustrated, will represent a combination of modern trends in architectural design and age-old settings such as terraces and sunken gardens. The design of J & C Power Heaters makes them ideally suited for heating such buildings. They are engineered in accordance with thoroughly modern heating principles. With a maximum of direct radiation surface, they capture more usable heat from a relative minimum of fuel. One-piece welded construction of best obtainable steel insures a gas-tight unit. • Smooth, forced air system with ample humidity control. Compact design, trim lines. Today, J & C Power Heaters from 160,000 to 2,800,000 B.T.U. output are heating many types of buildings—homes, schools, churches, stores, and apartment dwellings. Oil, gas, or coal fired—suitable for butane firing. Dealers—assure yourself of the BIG furnace installations in 1947 by contacting your distributor and getting the facts about the complete line of J & C Power Heaters.



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Heating Piping & Air Conditioning

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Associate Editor
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Elizabeth S. Galloway

Advertising Staff

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Telephone: Murray Hill 9-8293

Robert A. Jack
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Chicago
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George C. Cutler
Chicago
Telephone: State 6916

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Los Angeles
Telephone: Tucker 2779

Publisher
Frank P. Keeney

Manager
Charles E. Price

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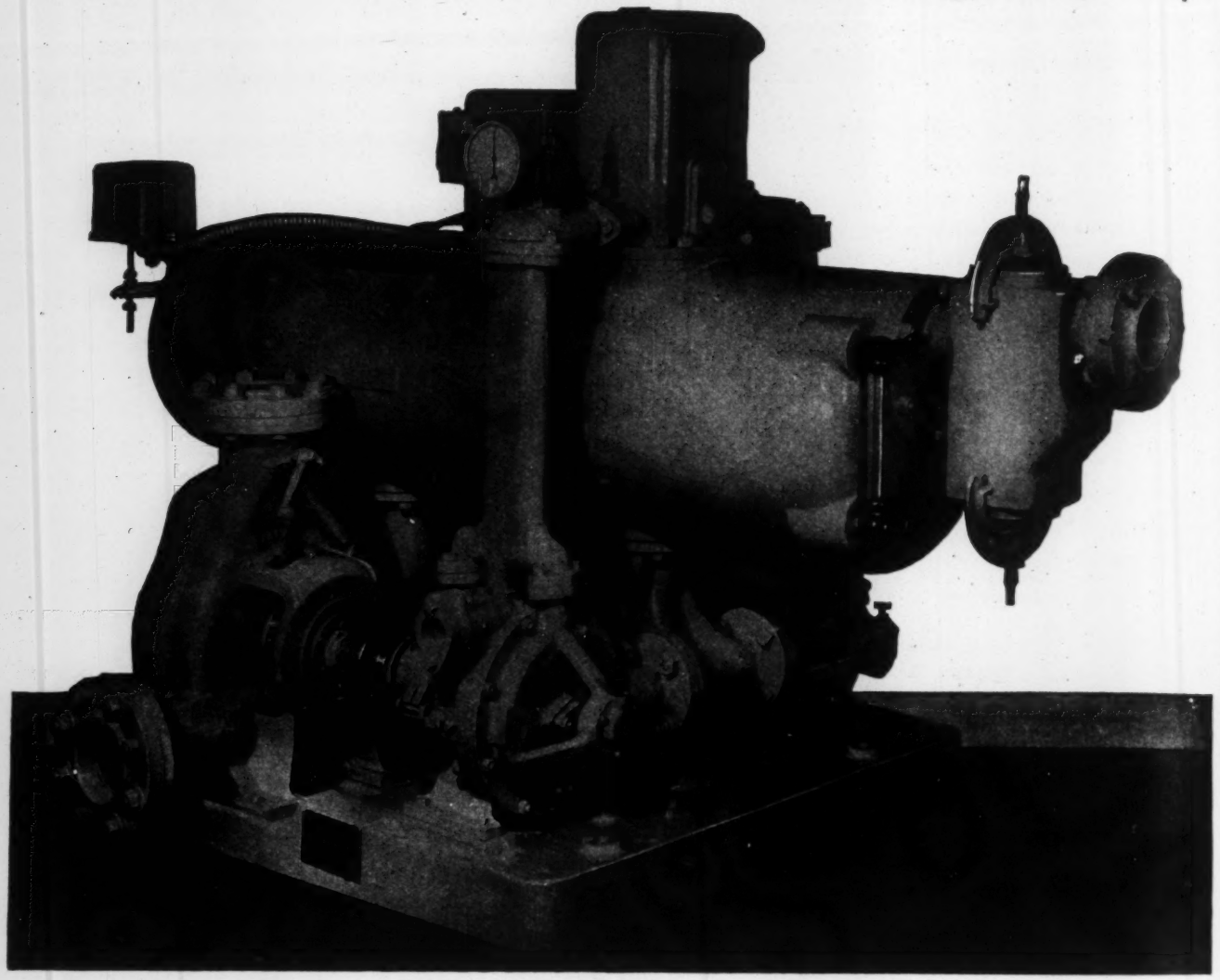
Where Heat Must Not Fai -
Install this SAFE Heating Pump!



In Hospitals, Greenhouses, Schools, Public Buildings, Theatres, wherever heating systems must not fail, install the Nash Vapor Turbine, for it is entirely independent of electric current failure, and continues to operate as long as there is steam in the system.

More than that, the Vapor Turbine is a most economical pump, for the elimination of electric current does away with current cost, the largest single item in the operation of an ordinary return line heating pump.

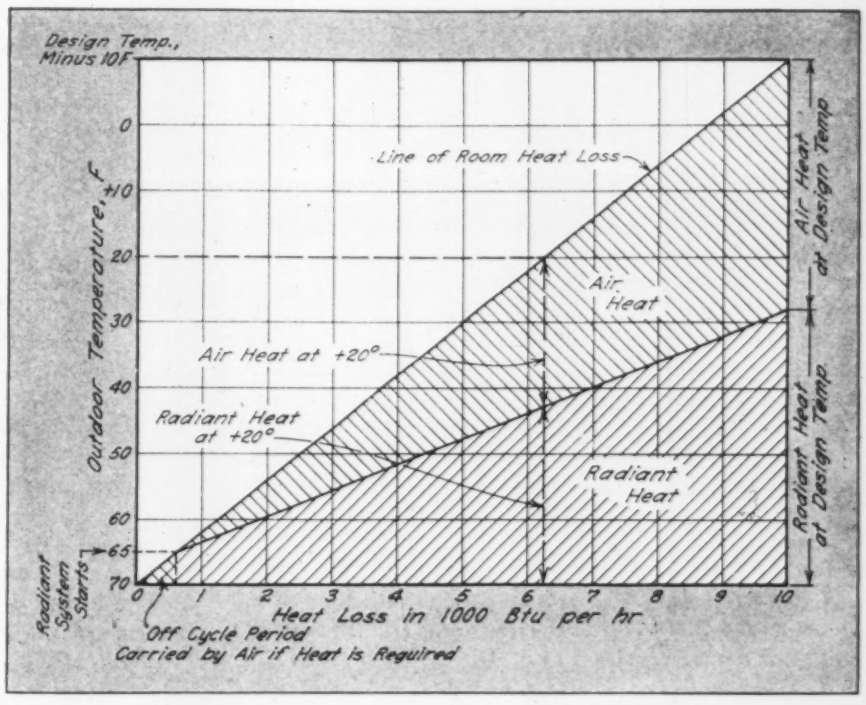
Greater savings still are effected by the Vapor Turbine in the system, for the reason that this pump operates continuously. It is the only pump that can do this with economy. Continuous operation means uniform circulation, and uniform circulation saves steam.

The Nash Vapor Turbine has but one moving part, rotating in the casing without metallic contact, and requiring no internal lubrication. Quiet, compact, and trouble-proof. Bulletin A-290 is free on request.

THE NASH ENGINEERING COMPANY

SOUTH NORWALK, CONNECTICUT, U. S. A.

SPLIT SYSTEMS using forced air with a direct method of heating are not new, but the combination of forced air and radiant heating as installed in the Benjamin Electric Mfg. Co.'s new product development and testing laboratory is considered to be both new and interesting. This scheme was employed to overcome the lack of immediate response to changes in outdoor temperature which—according to the authors—is an inherent defect of radiant heating . . . E. R. Gritschke, consulting engineer, and J. W. Scharres, of his office, tell why and how the system was designed; their article, confined to the essentials, is easily readable, and doesn't go into unnecessary detail.



Distribution of heat in a radiant-air split system

Split System Heats and Conditions Product Development, Testing Lab

E. R. Gritschke and J. W. Scharres Tell How Scheme To Overcome Obectionable Heat Lag Was Designed

DESIGN OF the heating and air conditioning systems for the new product development and testing laboratory for the Benjamin Electric Mfg. Co. at Des Plaines, Ill., provided a new and interesting application for a split system of heating. The building is a one story "modernistic" structure for use in the design, development, and testing of new lighting products, and incorporates laboratory, shop, and testing facilities as well as conference, office, and waiting rooms. Intended also as a medium for lighting applications, the building has extensive glass and glass block areas for the display of night illuminating effects.

Why Forced Air and Radiant Heating?

The application of a split system using forced air in combination with a direct method of heating is not new, but the combination of air and radiant heating as installed in this building is considered both new and interesting. This combination provides a means for installing both air conditioning and radiant heating in a structure at a cost well within the range of most construction budgets.

The building is completely air conditioned and a radiant system of heating is desirable not only for the heating advantages provided but also so that maximum wall areas will be available for the installation of electrical equipment.

The extensive glass and roof areas cause winter heat losses of such magnitude that a system of radiant heating using floor coils only would have been inadequate. The roof construction, of poured gypsum with exposed steel beams, provided no means for installing additional ceiling coils and the walls are of brick without other interior finish, prohibiting the installation of wall coils. The solution of the problem was the split system.

Split systems of heating using direct radiation or convectors in combination with air have been in use for many years and the advantages and economies are well known. Where the building is to be provided with an air conditioning system for summer use, it is both logical and economical to utilize such a duct system for winter heating to the greatest possible extent.

Full use of the air system for winter heating is not possible or practical due to the fact that the ratio of the heat delivered by the air to the space heating requirement is not the same for the various rooms. Internal heat loads and sun effect add heavily to the summer load—but contribute little during the heating season. In order to correct this inequality a source of heat in

addition to the air is required, so that each space will be properly heated to the desired temperature.

Inherent Defect of Radiant Heating

There is no reason why a radiant heating system cannot be used to accomplish this purpose. An inherent defect of a radiant heating system is its "lag," or lack of immediate response to sudden changes in outdoor temperature. Although the water temperature in the system responds instantly, sudden increases in outdoor temperature result in overheating due to the heat already absorbed by the structure which is beyond the reach of the control. The reverse is true on a sudden decrease in outdoor temperature, resulting in underheating during the period in which the heated surfaces of the structure are attempting to reach the required temperatures.

It is generally conceded that the average radiant heating system using floor coils embedded in concrete will lag several hours behind outdoor conditions. Various means of control have been suggested and used but all such methods sense the outdoor conditions or a combination of outdoor and indoor temperatures to control the water temperature in the system. None of the systems is able to control the heat once it has been absorbed by the structure, nor are control systems able to increase rapidly the temperature of heated surfaces to balance sudden drops in outdoor temperature.

Warm Air Responds Instantly

Warm air, on the other hand, will respond instantly to changes in indoor temperature. What is therefore more natural than to combine the two systems, utilizing the quick response of the air system to overcome the lag of the radiant installation, thereby obtaining a split system which retains the good points of both methods of heating? This conclusion formed the basis of design for the heating and air conditioning systems for this building.

The requirements for summer cooling were calculated in the usual manner and the air system was completely designed with total disregard of the winter heating requirements. In this building, a single zone system was selected due to the governing effect of roof sun load which created a *summer* peak for the entire building at approximately the same time. The corridor, which serves as a return air plenum, provides most of the south exposure and was therefore disregarded as a separate zone due to its relative unimportance.

Winter heat losses were then calculated in the usual manner. Various floor coverings—such as linoleum and terrazzo—involved a variety of transmission coefficients which resulted in the final selection of a maximum water temperature for the floor system of 115 F. With water at this temperature, the surface temperatures for the linoleum and terrazzo floors were calculated at 85 F and the total emission taken as 35 Btu per hr per sq ft of heated surface.

"Key Room" Selected

From this point the calculations proceeded in the usual manner for a split system. Heating loads and cooling cfm's were tabulated for each individual room and an analysis was made to determine which of the spaces had the least supplied air volume per 1000 Btu heat loss. This room was considered the "key" room and determined the temperature at which the air system functioned for all rooms. The entire floor of the key room was then provided with radiant floor coils.

The so-called key room is normally the only room which has the entire floor area radiantly heated. All other rooms, having a ratio of supplied air volume to heat loss greater than that of the key room, are provided with coils in only a part of their floor areas. This method will apply in practically all cases, although the designing engineer is advised to check the total input to each room at the conclusion of the calculations.

The maximum entering air temperature was then calculated for the key room by deducting the floor emission from the total room heat loss and applying the usual formula. As the building is provided with only one zone of heating, it is apparent that all spaces will receive air at the same temperature as the key room. Therefore, for all other rooms, the procedure was reversed and the heat input from the air system was deducted from the total room heat loss to deter-

Behind the curved glass brick wall in the center is the product development laboratory and model shop, and to the right is the photometric laboratory for testing lighting equipment. The "weathering tower" provides facilities for testing outdoor fixtures. Perkins & Will were the architects, E. R. Gritschke was the consulting engineer, H. S. Kaiser Co. installed the heating and conditioning

mine the required area of heated floor. To summarize, the sum of the Btu's provided by the air system plus the Btu's provided by the floor system must—for all spaces—add up to the calculated heat loss. A small error is involved in assuming straight line variation for the floor emission but this is considered negligible for the average installation.

The radiant heating system is a two pipe, forced circulation, reversed return, hot water system with floor coils throughout and mains overhead. This arrangement insures positive removal of entrained air from the piping system. Gate valves and a balancing cock were installed for each coil, thereby providing a means for isolating the coil for repair and at the same time permitting an adjustment for possible unbalance in the water system.

Hot water for the radiant system is provided by a converter which is supplied with steam at a reduced pressure of 25 psi from a central system.

Control for Heating

The control for winter heating consists simply of an outdoor thermostat that establishes the water temperature leaving the converter in inverse proportion to outdoor temperature. Floor water temperature is varied from 70 to 115 deg for an outdoor variation of 65 deg to minus 10 deg respectively. The air system is controlled by a return air thermostat set at 70 deg that varies the temperature of the air leaving the conditioning system by means of a modulating steam valve. The return air thermostat is piloted by a low limit device in the supply fan discharge to prevent entering air temperatures below 68 deg.

With the described arrangement the floor temperature can lag behind outdoor temperature and the air will respond instantly to any change in indoor temperature. As the floor system overcomes the lag period and reaches the required surface temperature the air system will respond to maintain the desired balance.

Most Practical for Modern Structures

It is believed that this arrangement is most practical for modern structures involving the installation of both cooling and radiant heating systems. By using the air system to serve a part of the heating load, the size and cost of the radiant heating installation is held to a minimum without the appreciable loss of any advantages. Application of split radiant systems to air conditioned buildings brings the combined cost of both systems within normal building appropriations and at the same time eliminates the lag of radiant heating, its one defect.

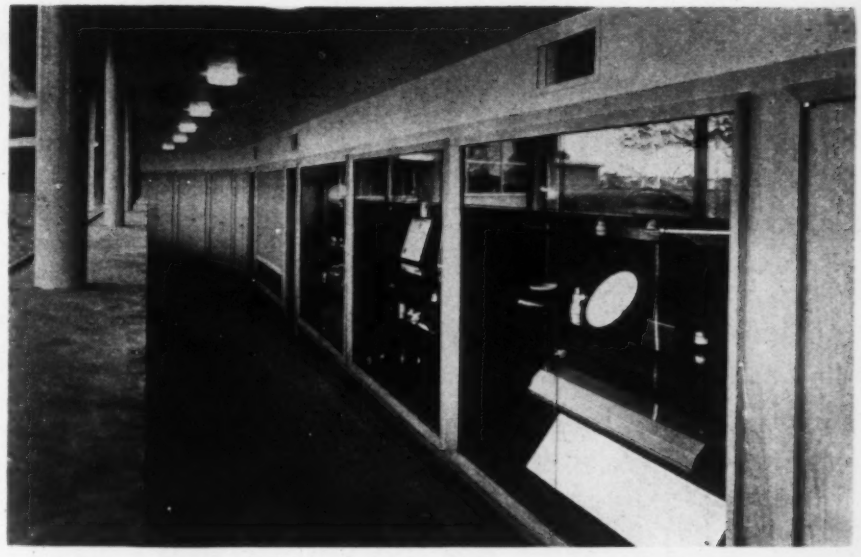


Plate glass display cases are provided for the company's products in the entrance corridor. The windows to the left are of heat absorbent plate glass

Floor coils in the model shop, showing the headers and bent laterals. This arrangement was necessary due to the curved shape of the room

Stoker Manufacturers Association Issues New Information Manual

The first edition of the SMA Information Manual was published in August, 1943. Because of its popularity as a reference to stoker manufacturers' names, addresses, and personnel, a new 4th edition has been published.

All of the information in the manual has been brought up to date and the listings included cover members, committees, officers, by-laws, and so on.

Copies are now available at 50 cents each and orders should be sent to the Stoker Manufacturers Association, 307 N. Michigan Ave., Chicago 1, Ill.

Methods of Making

PIPING FLEXIBILITY Analyses

TABULAR INTEGRATION METHOD

By W. G. Hooper

Vice President

Midwest Piping

& Supply Co.

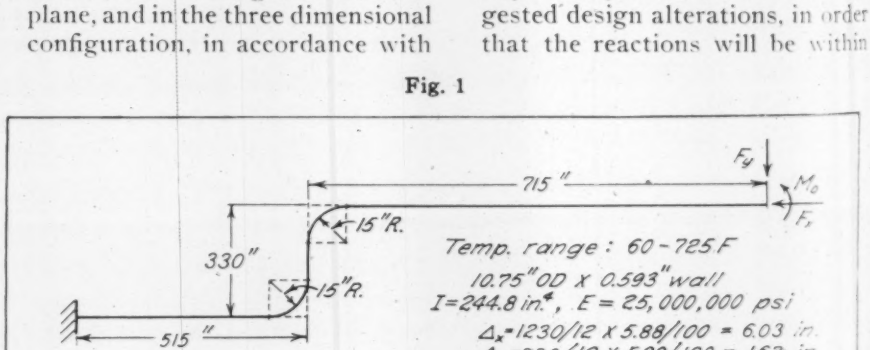
THERE ARE numerous methods of analyzing the flexibility of piping systems and a great amount of material on this important subject has been published. In the June HPAC, Sabin Crocker and Arthur McCutchan reviewed the various methods, and suggested that the advocates of the different schemes each briefly outline the merits of his method and show the solution of two problems; in this way, the reader can judge for himself the suitability of the different calculation procedures in his own piping work. . . . S. W. Spielvogel followed this suggestion in the July issue, explaining the essentials of the elastic center method, and in September M. J. Fish discussed the graphical method. This month Mr. Hooper covers the tabular integration method and solves the two problems given by Messrs. Crocker and McCutchan by this means.

IN THE June issue of Heating, Piping & Air Conditioning, Sabin Crocker and Arthur McCutchan described briefly several methods adopted by various engineers and piping designers for the calculation of forces, moments, and stresses in piping configurations.

As the "tabular integration method," developed by R. C. Powell of the Pacific Gas and Electric Co. and adopted by the Midwest Piping & Supply Co., was one of the methods mentioned in their article, this is an opportune time to present to the reader a more detailed description of this method and the mechanics of its operation by submitting the work sheets or forms involved in the computations for calculating the forces, moments, and stresses occurring in the Z bend configuration in one plane, and in the three dimensional configuration, in accordance with the design data and dimensions of Figs. 1 and 2, respectively. However, neither of these configurations is really representative of the shapes usually encountered in power piping design, as one plane configurations are an exception and it is really a rare occurrence to encounter a three plane configuration with but one line or element in each plane.

During the past five or six years, the piping fabricator—particularly if he is also an erector—has been frequently called on to submit force, moment, and stress analyses of the piping he is to fabricate and erect. In so doing, he morally shoulders the responsibility as to adequate flexibility of the piping system in question, and in case of insufficient flexibility, he usually is requested to submit suggested design alterations, in order that the reactions will be within

Fig. 1



safe limits and comply with the requirements specified by the equipment manufacturer — especially the turbine builder.

Analyses of the various methods mentioned above indicate that they have all been derived from Castigliano's theorem (1875 and 1879) and Maxwell's theorem (1864). Considering the length of time that these theorems have been the basis for the design of curved beams, it is only logical to presume that their accuracy has been fully established.

Assembly "Floats in Space"

Present day practice in the design of piping systems to care most efficiently for thermal expansion is to anchor the configuration at the ends only and support the intermediate lines so that the entire assembly theoretically floats in space. Both ends being anchored, the linear expansion between the anchors, caused by temperature change, is compressed back into the configuration.

In order to keep the stress within safe limits there must be sufficient straight pipe, bends, or welding elbows in the assembly to absorb the linear expansion acting parallel to the axes, and each line must play its own part in its contribution to the flexibility of the complete configuration. The number of lines or elements in the average three plane configuration is seldom less than six, and frequently there are as many as 15.

In the tabular integration method, the entire assembly is considered as being composed of straight pipe and all changes in direction as being made with square corners or welding elbows; in the latter case, the welding elbow is not considered to have any greater flexural property than that of the equivalent amount of straight pipe. If full credit should be taken for the flexibility of the welding elbow as computed in accordance with the flattening theory, it is reasonable to presume that a dangerous stress concentration might be developed in the elbow itself, and in case the wall-thickness of the piping material is relatively heavy (greater than schedule 120), the increased flexibility due to the flattening theory is practically negligible.

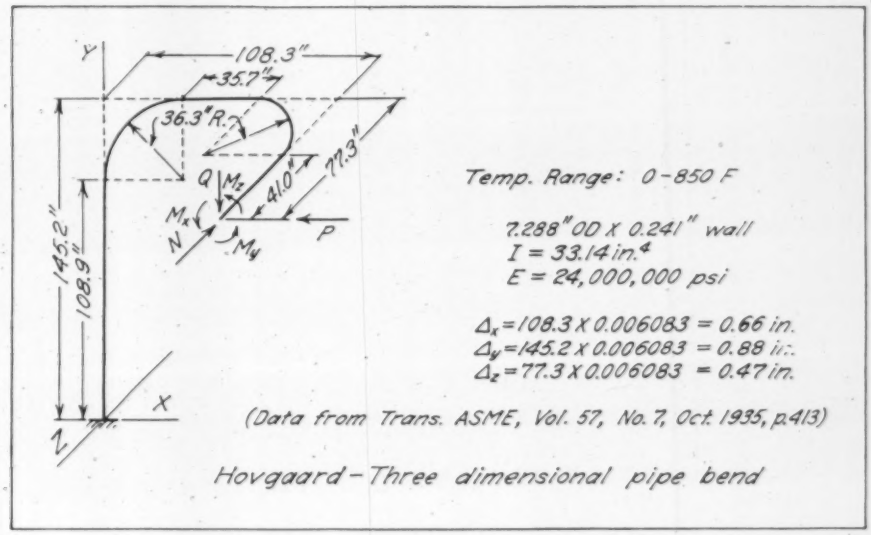
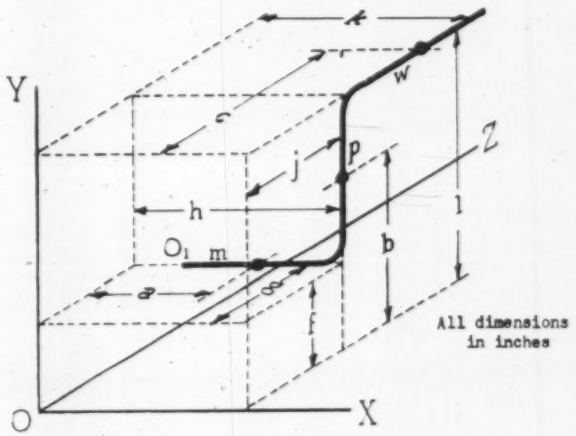


Fig. 2

Fig. 3

RELATION OF THE CONFIGURATION
TO THE AXIS LINES AND TO ITS SYSTEM OF COORDINATES



SYMBOLS

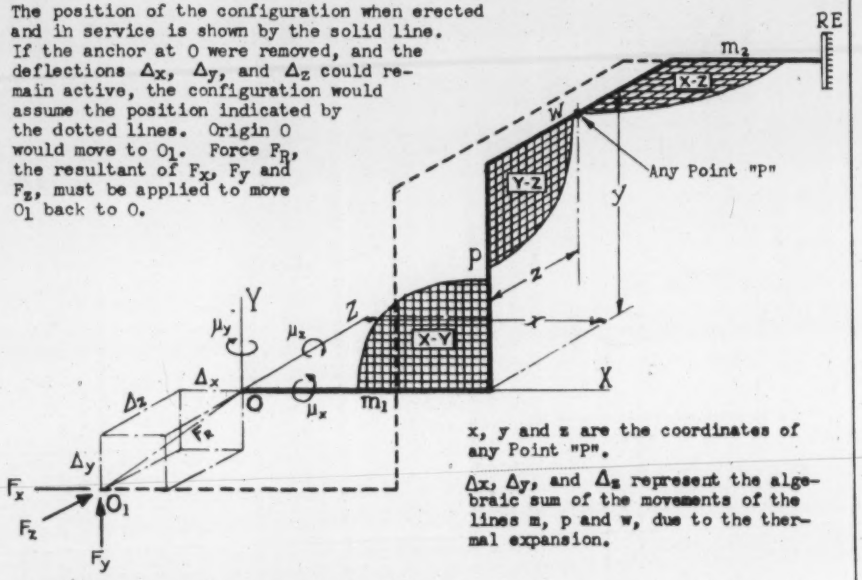
X, Y and Z - - - - - - - Axis Lines of the Configuration
m_1, m_2, m_3 ..... - - - Length of Lines parallel to the X-Axis;
p_1, p_2, p_3 ..... - - - Length of Lines parallel to the Y-Axis;
w_1, w_2, w_3 ..... - - - Length of Lines parallel to the Z-Axis;
a_1, a_2, a_3 ..... - - - Coordinates of the Mid-Points of m_1, m_2, m_3 .....;
b_1, b_2, b_3 ..... - - - Coordinates of the Mid-Points of p_1, p_2, p_3 .....;
c_1, c_2, c_3 ..... - - - Coordinates of the Mid-Points of w_1, w_2, w_3 .....;
f_1, f_2, f_3 .....
g_1, g_2, g_3 ..... - - - Coordinates of the Lines m_1, m_2, m_3 .....;
h_1, h_2, h_3 .....
j_1, j_2, j_3 ..... - - - Coordinates of the Lines p_1, p_2, p_3 .....;
k_1, k_2, k_3 .....
l_1, l_2, l_3 ..... - - - Coordinates of the Lines w_1, w_2, w_3 .....;
O - - - - - - - - - - - Origin of the System, and Intersection of X, Y and Z;
O_1 - - - - - - - - - - Origin End of the Configuration.

Note: When delineating the Configuration the Point O_1 should coincide with the intersection Point O of axis lines X, Y and Z, so that as many as possible of the coordinates will be reduced to zero.

DR. wgh TR. pb DWG. NO.
CH. DATE 8-26-46

FORCE AND MOMENT REACTIONS

The position of the configuration when erected and in service is shown by the solid line. If the anchor at O were removed, and the deflections Δ_x, Δ_y, and Δ_z could remain active, the configuration would assume the position indicated by the dotted lines. Origin O would move to O_1. Force F_R, the resultant of F_x, F_y and F_z, must be applied to move O_1 back to O.



x, y and z are the coordinates of any Point "P".

Δx, Δy, and Δz represent the algebraic sum of the movements of the lines m, p and w, due to the thermal expansion.

Should any external movement at anchor points, due to expansion of equipment, tend to reduce the distance between anchor points, this movement is positive (+); and negative (-), if this distance is increased.

μ_x, μ_y, and μ_z represent the moments at O, acting about the X, Y and Z axes.

M_x, M_y and M_z are moments at any point due to the forces F_x, F_y and F_z acting together with the moments μ_x, μ_y, and μ_z.

Any point on a three-plane configuration is subjected to three moments, acting in the three planes formed by the system of coordinates. The moment that acts in the plane at right angles to the pipe axis, produces Torsion, and the other two moments produce Bending. The resultant Bending Moment is the **vectorial** addition of the other two moments.

If the selected Point "P" is at the junction of any two lines, it may be considered as being on either of the two axes. Then there will be two torsional moments and two sets of bending moments. Unless it is possible to select the axis that will show the greater bending moment by observation, then calculate both cases, and use the larger.

Fig. 4

SUMMARY and DESIGN DATA

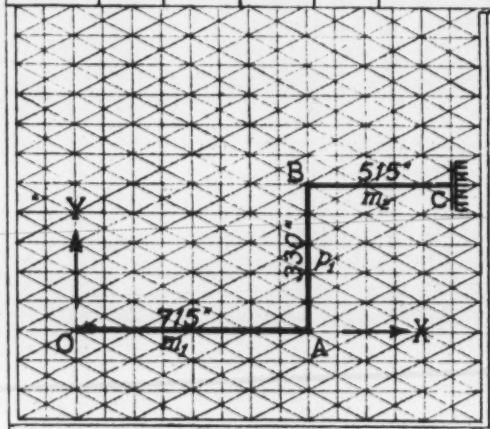
Project: _____

Shape No. Fig. 1

Description of Configuration: Z Bend

DESIGN DATA

Outside Diameter D	Wall Thkn. T	Schedule No.	Pressure P	Temp.	Material	A.S.T.M. Spec.	E·10⁶	I	e (in./100 ft.)
10.75	.593	80	650	725	C.S. Seamless	A-106 Gr. A.	25	244.8	5.88



Length of Lines, inches

m_1	715	P_1	330	W_1	
m_2	515	P_2		W_2	
m_3		P_3		W_3	
m_4		P_4		W_4	
m_5		P_5		W_5	
m_6		P_6		W_6	

Deflections		Forces	
Δ_x	6.03 in.	F_x	3472 lbs.
Δ_y	1.62 in.	F_y	1419 lbs.
Δ_z	in.	F_z	-- lbs.
		F_R	3750 lbs.

Max. All. Comb. Stress (S_c) 13650 p.s.i. Longitudinal Stress (S_L) 2470 p.s.i

MOMENTS AND STRESSES

At	MOMENTS in lbs.		STRESSES in p.s.i.		
	Torsional M_T	Bending M_B	Torsional S_T	Bending S_B	Equivalent S_{EQ} ①
O	--	403500	--	8887	11357
A	--	-609700	--	13411	15881
B	--	536100	--	11794	14264
C	--	-196800	--	4330	6800
D					
E					
F					
G					

① The Equivalent Stress (S_{EQ}) should not exceed the Max. All. Combined Stress (S_c).
Note: If Cold Sprung 50%, the Forces, Moments & Stresses may be reduced 33-1/3%.

Remarks: _____ Eng. _____ Date: 9/1/40

Fig. 5

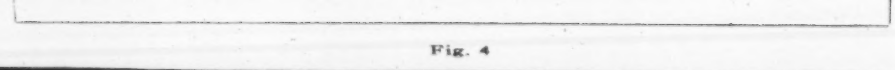


Fig. 4

Fig. 5

COMPUTATION SHEET A
ONE PLANE SHAPES

SHAPE NO. Fig 1

OWNER

JOB & LOCATION

Divisor Q = 300

	1	2	3	4	5	6	7	8	9	10	
	m	a	f	m·a	mf	m·a·f	n_m	f^2	m·n_m	m·f^2	Δx
1	2.38	1.19	0	2.83	—	—	1.89	—	4.50	—	3.51
2	1.72	3.24	1.10	5.57	1.89	6.13	10.74	1.21	18.47	2.08	2.52
3											
4											
5											
Σ	4.10			8.40	1.89	6.13			22.97	2.08	6.03
	p	h	b	p·h	p·b	p·b·h	h^2	n_p	p·h^2	p·n_p	Δy
1	1.10	2.38	.55	2.62	.60	1.44	5.66	.40	6.23	.44	1.62
2											
3											
4											
5											
Σ	1.10			2.62	.60	1.44			6.23	.44	1.62
	L / Σm+p		SX·SY	SX / Σ*4	SY / Σ*5	Ixy / Σ*6	$(SX)^2$	$(SY)^2$	Iy / Σ*9	Ix / Σ*10	$\bar{l}_3$ / Ix+Iy
	5.20		27.44	11.02	2.49	7.57	181.44	6.20	29.20	2.52	

$n_m = \frac{m^2}{12} + a^2$, $n_p = \frac{p^2}{12} + b^2$

$Jx = Ix - \frac{(SY)^2}{L} =$ 1.33

$Jy = Iy - \frac{(SX)^2}{L} =$ 6.86

$Jxy = Ixy - \frac{SX \cdot SY}{L} =$ 2.29

$Jx \cdot Jy =$ 7.79

$(Jxy)^2 =$ 5.24

$Jx \cdot Jy - (Jxy)^2 =$ 2.55

$\frac{E \cdot I}{Q^3} = \frac{35 \cdot 244.8 \cdot 10^6}{27 \cdot 10^6} =$ 226.7

$Fx = \frac{E \cdot I}{Q^3} \cdot \frac{Jy\Delta x + Jxy\Delta y}{Jx \cdot Jy - (Jxy)^2} =$ 3472 lbs.

$Fy = \frac{E \cdot I}{Q^3} \cdot \frac{Jx\Delta y + Jxy\Delta x}{Jx \cdot Jy - (Jxy)^2} =$ 14.9 lbs.

μ at O = $\frac{Fy \cdot SX - Fx \cdot SY}{L} =$ 1345 · Q in/lbs.

Mᵩ (in.lbs.) = (Fx·Y − Fy·X + μ)Q

Mᵩ at O = 403500 when X = 0 Y = 0

Mᵩ at A = −609700 " X = 2.38 Y = 0

Mᵩ at B = 536100 " X = 2.38 Y = 1.10

Mᵩ at C = −196800 " X = 4.10 Y = 1.10

Mᵩ at ___ = ___ " X = ___ Y = ___

Mᵩ at ___ = ___ " X = ___ Y = ___

Sᵩ at any point = Mᵩ at that point · $\frac{F}{I}$, and $\frac{F}{I} = \frac{5.375}{244.8} = .022$

X is the Abscissa & Y is the Ordinate to the Selected Point.

Engineer A.O.S.H.

Date 8-1-46

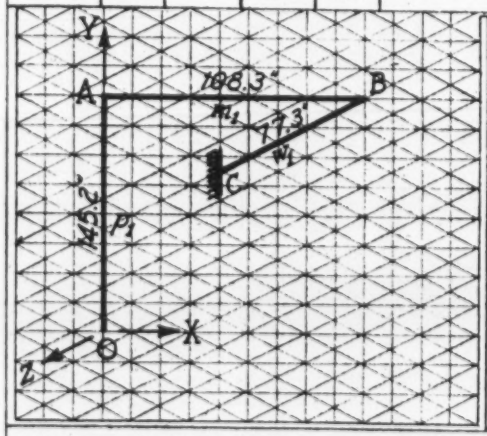
Fig. 6

SUMMARY and DESIGN DATA | Project: | Shape No. Fig. 2

Description of Configuration: Three Dimensional Bend

DESIGN DATA

Outside Diameter D	Wall Thkn. T	Schedule No.	Pressure P	Temp.	Material	A.S.T.M. Spec.	$E \cdot 10^6$	I	e (in./100 ft.)
7.288	.241	--	--	850	--	--	24	33.14	7.3



Length of Lines, inches

m_1 108.3	p_1 145.2	w_1 77.3
m_2 ___	p_2 ___	w_2 ___
m_3 ___	p_3 ___	w_3 ___
m_4 ___	p_4 ___	w_4 ___
m_5 ___	p_5 ___	w_5 ___
m_6 ___	p_6 ___	w_6 ___

Deflections		Forces	
Δ_x .66	in.	F_x 1766	lbs.
Δ_y .88	in.	F_y 1752	lbs.
Δ_z .47	in.	F_z 608	lbs.
		F_R 2562	lbs.

Max. All. Comb. Stress (S_c) -- p.s.i. Longitudinal Stress (S_L) -- p.s.i.

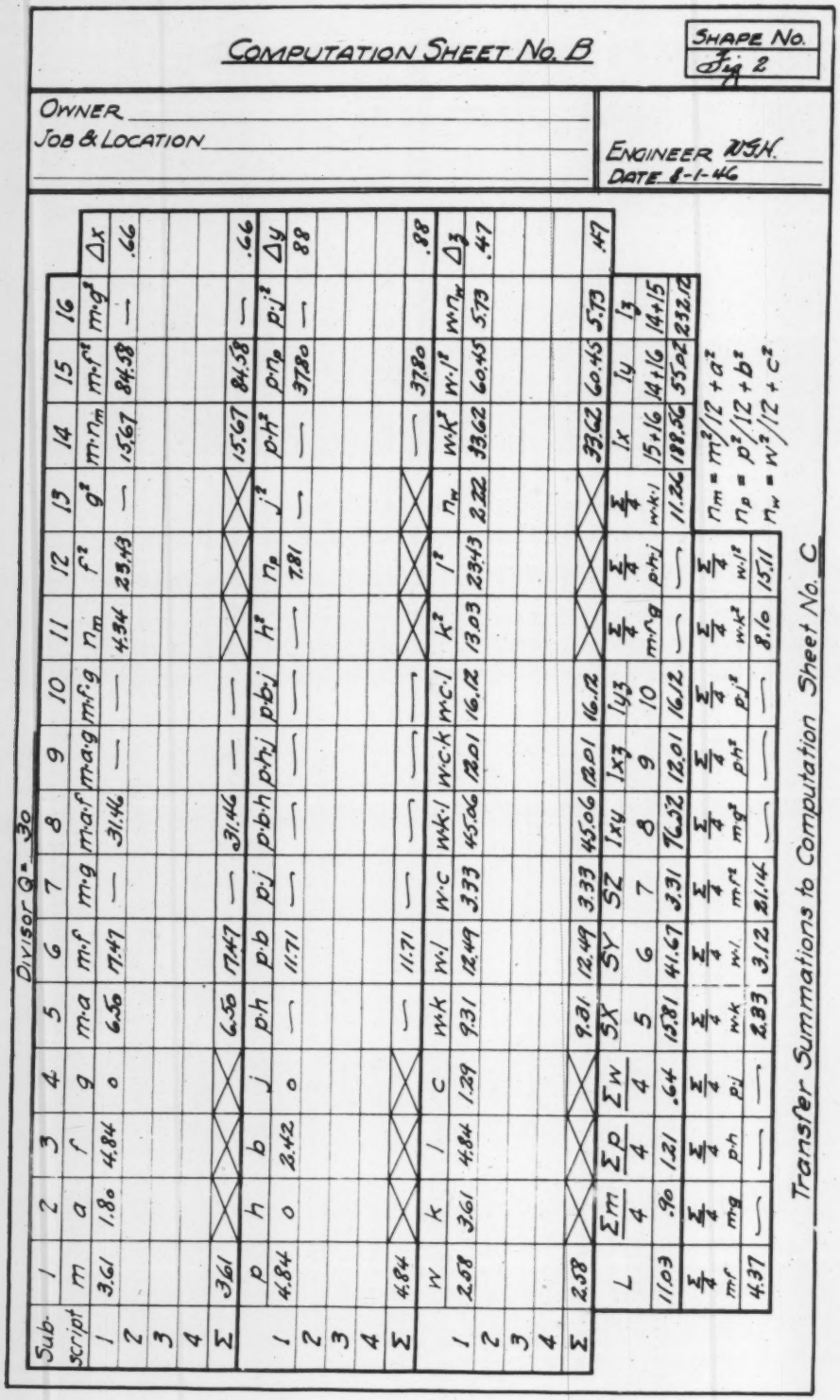
MOMENTS AND STRESSES

At	MOMENTS in lbs.		STRESSES in p.s.i.		
	Torsional M_T	Bending M_B	Torsional S_T	Bending S_B	Equivalent S_{EQ} ①
O	9240	133860	508	14725	
A	-9240	138660	508	15253	
B	-32490	78900	1787	8680	
C	-54960	124560	3023	13702	
D					
E					
F					
G					

① The Equivalent Stress (S_{EQ}) should not exceed the Max. All. Combined Stress (S_c).
Note: If Cold Sprung 50%, the Forces, Moments & Stresses may be reduced 33-1/3%.

Remarks: ___ Eng. ___ Date: 9/1/46

Fig. 7



COMPUTATION SHEET No. B

SHAPE NO. Fig. 2

OWNER

JOB & LOCATION

ENGINEER WSH.

DATE 8-1-46

DIVISOR Q = 30

Sub-script	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
	m	a	f	g	m·a	m·f	m·g	m·a·f	m·a·g	m·f·g	n_m	f^2	g^2	$m \cdot n_m$	$m \cdot f^2$	$m \cdot g^2$	Δx
1	3.61	1.80	4.84	0	6.50	17.47	—	31.46	—	—	4.34	23.43	—	15.67	84.58	—	.66
2																	
3																	
4																	
Σ	3.61				6.50	17.47	—	31.46	—	—				15.67	84.58	—	.66

Sub-script	p	h	b	j	p·h	p·b	p·j	p·b·h	p·h·j	p·b·j	h^2	n_p	j^2	$p \cdot h^2$	$p \cdot n_p$	$p \cdot j^2$	Δy
1	4.84	0	2.42	0	—	11.71	—	—	—	—	—	7.81	—	—	37.80	—	.88
2																	
3																	
4																	
Σ	4.84				—	11.71	—	—	—	—				—	37.80		.88

Sub-script	w	k	l	c	w·k	w·l	w·c	w·k·l	w·c·k	w·c·l	k^2	l^2	n_w	$w \cdot k^2$	$w \cdot n_w$	Δz	
1	2.68	3.61	4.84	1.29	9.31	12.49	3.33	45.06	12.01	16.12	13.03	23.43	2.22	13.62	60.45	5.73	.47
2																	
3																	
4																	
Σ	2.58				9.31	12.49	3.33	45.06	12.01	16.12				13.62	60.45	5.73	.47

	L	Σm/4	Σp/4	Σw/4	5X	5Y	7	8	9	10	$\frac{\Sigma}{4}$ m·g	$\frac{\Sigma}{4}$ k^2	$\frac{\Sigma}{4}$ l^2	$\frac{\Sigma}{4}$ $w \cdot k^2$	$\frac{\Sigma}{4}$ $p \cdot j^2$	$\frac{\Sigma}{4}$ $w \cdot l^2$	$\frac{\Sigma}{4}$ $p \cdot h^2$	$\frac{\Sigma}{4}$ $m \cdot g^2$	
		4	4	4	5X	5Y	7	8	9	10									
	11.03	.90	1.21	.64	15.81	41.67	3.31	76.32	12.01	16.12	—	—	—	—	—	—	—	—	
		Σm/4 m·f	Σp/4 p·h	Σw/4 w·l	Σ/4 w·k	Σ/4 m·f	Σ/4 m·g	Σ/4 m·a·f	Σ/4 p·h²	Σ/4 p·j²									
	4.37	—	—	—	2.83	3.12	21.14	—	—	—									

$n_m = m^2/12 + a^2$

$n_p = p^2/12 + b^2$

$n_w = w^2/12 + c^2$

Transfer Summations to Computation Sheet No. C

Fig. 8

In this method the necessity of handling large numbers is avoided by devaluating each line or component part of the assembly by dividing the length of each line by any selected number Q and this quotient is used as the value of m, p, and w (the length of the lines parallel to the X, Y, and Z axes respectively) in the forms. Values of Q usually range from 50 to 300 (optional to the designer) depending on the length and number of lines in the assembly.

To emphasize the advantage derived from the use of the divisor Q, assume one of the lines in the assembly as being 25 ft or 300 in. long; dividing by an assumed value of Q (say 300) the quotient would be 1. The formula requires that the length of the line be raised to the third power; then, in this method, there would be only the value of 1 to deal with, whereas in most of the other methods the cube of the line would be 27,000,000. This difference exists throughout the entire computation.

Forms Help Avoid Errors

The forms have been developed to provide a positive sequence in the computations, to eliminate any possible chance of the omission of a single step in the procedure and to permit rapid sliderule checking.

The simplicity of this method is such that the novice successfully can solve unsymmetrical one and three plane problems which heretofore have been referred to specialists in flexibility analyses.

From a comparison of the form employed for the Z bend in one plane, Fig. 1, and the three dimensional bend in three planes, Fig. 2, the similarity of the two forms is evident; in fact, they are identical except that in the one plane form, the tabulations pertaining to the line w parallel to the Z axis are omitted and the equations for the forces F_x and F_y are merely the algebraic solution of the simultaneous equations:

$$F_x J_x - F_y J_{xy} = \Delta_x EI$$
$$-F_x J_{xy} + F_y J_y = \Delta_y EI$$

These forms are to be used for configurations in one or three planes regardless of the number of lines in the assembly or for assemblies composed of lines having different moments of inertia. They are also used, with minor modifications, for assemblies constructed of corrugated pipe and for assemblies having three anchor points.

The relation of the configuration to the axis lines and to its system of coordinates is graphically shown in Fig. 3.

Any flexural analyses should indicate not only the reactions but also the bending and torsional stresses developed at elbows or bends and at anchor points.

Instructions For Using Forms

The following procedure should be followed in the manipulation of this method and in the use of the forms.

The letters m, p, and w, the designating symbols of lines parallel to the X, Y, and Z axes, are frequently used without the sub-

script, and then are used in their collective form, as the subscript merely denotes its position in the configuration.

1. (a) On the summary design data sheet, fill in the spaces allotted to size, weight, and material of the pipe, operating pressure, temperature, modulus of elasticity at operating temperature, moment of inertia, and coefficient of thermal expansion in inches per 100 ft.

(b) Sketch the shape of the configuration in the panel provided—flat if in one plane, and isometric if in three planes. Consider X axis as being horizontal and the Y axis as vertical, and intersecting near the lower left corner.

The configuration may be set up in any position regardless of its actual position in the piping layout.

The left hand end of the configuration or the origin O should coincide with the intersection of the X, Y, and Z axes, in order that the lengths of as many as possible of the coordinates shall have the value of zero.

To simplify computations, endeavor to so arrange the assembly that no part of it will project outside the quadrant.

(c) Convert the length of each line into inches, designate those lines parallel to the X axis as m, parallel to the Y axis as p, and parallel to the Z axis as w.

2. Use Form A (Fig. 6) if the configuration is in one plane and Form B (Fig. 8) if in three planes.

(a) Devaluate the actual length of lines m, p, and w by dividing each by the Divisor Q.

(b) Set these new values of m, p, and w in their respective spaces in the first column of the form.

3. Using values m, p, and w in the first column as basic:

(a) Determine the lengths of the distance a, b, or c to the midpoint of the line m, p, and w, respectively.

(b) Determine the coordinates f and g, for line m, h and j for line p, and k and l for line w.

(4) Compute the linear expansion of each based on the actual length of the line in feet multiplied by the coefficient of expansion (e) in inches per 100 feet, and tabulate the result in the last column at the extreme right of the form.

5. Complete the arithmetical computations clearly indicated on the form until each progressive step has been completed and the final results have been determined. Then transfer results from the form to the summary and design data sheet.

The completion of steps 1, 2, 3, and 4 may require more or less technical knowledge, but the successive steps 5 and on can be accomplished by anyone who has had only high school arithmetic and algebra.

The computations can be very quickly done with a calculating machine or even a sliderule.

Occasionally, configurations are encountered made up of lines of different size and weight of pipe.

COMPUTATION SHEET NO. C
TRANSFERRED FROM COMPUTATION SHEET — NUMBER B —
SHAPE NO. Fig 2

OWNER
JOB & LOCATION

	½Σm	½Σp	½Σw					½Σm·g	½Σp·j	
	.90	1.21	.64					—	—	
+L	11.03	11.03	11.03							
	11.93	12.24	11.67							
	S_1	S_2	S_3							
	½Σp·h	½Σw·k		½Σm·f	½Σw·l					
	—	2.33		4.37	3.12					
+SX	15.81	15.81	+SY	41.67	41.67	+SZ	3.31	3.31		
	15.81	18.14		46.04	44.79		3.31	3.31		
	A_1	A_2		B_1	B_2		C_1	C_2		
	I_x 188.56	I_y 55.02		I_z 232.12						
	½Σp·j² —	½Σm·g² —		½Σm·f² 21.14						
	½Σw·l² 15.11	½Σw·k² 8.40		½Σp·h² —						
	203.67		63.42		253.26					
	D_1		D_2		D_3					
	I_{xy} 76.52	I_{xz} 12.01		I_{yz} 16.12						
	½Σw·k·l 11.26	½Σp·h·j —		½Σm·f·g —						
	87.78	12.01		16.12						
	E_1	E_2		E_3						
		D_1		D_2					D_3	
	$-B_2^2/S_3$ 171.05	203.67	$-C_1^2/S_1$ .92	63.42		$-B_1^2/S_1$ 177.68	253.26			
	$-C_2^2/S_3$ .90	171.95	$-A_2^2/S_3$ 28.20	29.12		$-A_1^2/S_2$ 20.58	198.26			
		31.72		34.30				55.00		
		α		β_2				γ_3		
	E_1 87.78	E_2 12.01		E_3 16.12						
	$-A_2B_2/S_3$ 69.62	$-A_1C_2/S_2$ 4.28		$-B_1C_1/S_1$ 12.77						
	18.16	7.73		3.35						
	β_1	γ_1		γ_2						
	$\beta_2\gamma_3$ 1886.50	$\beta_1\gamma_3$ 998.80		$\alpha\gamma_3$ 1744.60						
	$-\gamma_2^2$ 11.22	$+\gamma_1\gamma_2$ 25.80		$-\gamma_1^2$ 59.75						
	1875.28	1024.60		1684.85						
	a_1	b_1		b_2						
						$-\beta_1 b_1$ 18606.74		$\alpha \cdot a_1$	59483.88	
						$-\gamma_1 c_1$ 2519.83			21126.57	
									38357.91	
									V	
	$\beta_1\gamma_2$ 60.84	$\alpha\gamma_2$ 106.26		$\alpha\beta_2$ 1088.00						
	$+\beta_2\gamma_1$ 265.14	$+\beta_1\gamma_1$ 140.38		$-\beta_1^2$ 329.79						
	325.98	246.64		758.21						
	c_1	c_2		c_3						

Transfer Values to Summary Sheet # D

Engineer JOS. H.
Date 8-1-46

Fig. 9

FINAL COMPUTATION SHEET D
THREE PLANE BENDS

Shape No. Fig 2

OWNER

JOB & LOCATION

Recapitulation from computation sheet № C

A_1 = 15.81, A_2 = 18.14, B_1 = 46.04, B_2 = 44.79, C_1 = 3.31, C_2 = 3.31

a_1 = 1875.28, b_1 = 1024.60, b_2 = 1684.85, c_1 = 325.98, c_2 = 246.64, c_3 = 758.21

V = 38357.31, E = 24·10⁶, I = 33.14, EI = 795.36 ·10⁶, Q = 30, Q^3 = .027×10⁶

$N = \frac{EI}{Q^3V}$ = .77, S_1 = 11.93, S_2 = 12.24, S_3 = 11.67, Δ_x = .66", Δ_y = .88", Δ_z = .47"

Forces

$a_1\Delta_x$ 1237.68	$b_1\Delta_x$ 676.24	$c_1\Delta_x$ 215.15	$F_x = \theta_x N$ = 1766 lbs.
$+b_1\Delta_y$ 901.65	$+b_2\Delta_y$ 1482.67	$+c_2\Delta_y$ 217.04	$F_y = \theta_y N$ = 1752 lbs.
$+c_1\Delta_z$ 153.21	$+c_2\Delta_z$ 115.52	$+c_3\Delta_z$ 356.36	$F_z = \theta_z N$ = 608 lbs.
θ_x = 2292.54	θ_y = 2274.43	θ_z = 788.55	$F_R = \sqrt{F_x^2 + F_y^2 + F_z^2}$, F_R = 2560 lbs.

Moments about X, Y & Z axes at origin O

F_zB_1 27992.23	F_xC_2 5845.46	F_yA_2 31781.28	$\mu_x \cdot Q$ = 55800 in.lbs.
$-F_yC_1$ 5799.12	$-F_zA_1$ 9612.48	$-F_xB_2$ 79099.14	$\mu_y \cdot Q$ = -9240 in.lbs.
22193.20	−3767.02	−47317.86	$\mu_z \cdot Q$ = −121650 in.lbs.
÷ by S_1 = 1860	÷ by S_2 = −308	÷ by S_3 −4055	
μ_x	μ_y	μ_z	

Torsional Moments about any Point (P) on lines m, p & w about the X, Y & Z axes

$M_{Tx} = (F_yZ - F_zY + \mu_x)Q$
$M_{Ty} = (F_zX - F_xZ + \mu_y)Q$
$M_{Tz} = (F_xY - F_yX + \mu_z)Q$

} X, Y & Z are the co-ordinates of any point (P) on the lines m, p & w. (X, Y & Z axes respectively)

Bending Moments and Stresses at any point P

	P	X'	Y'	Z'
$M_{Bm} = \sqrt{(M_{Ty})^2 + (M_{Tz})^2}$ = 2630 ·Q in.lbs	B	3.61	4.84	0
·Q in.lbs				
$M_{Bp} = \sqrt{(M_{Tx})^2 + (M_{Tz})^2}$ = 4462 ·Q in.lbs	O	0	0	0
4622 ·Q in.lbs	A	0	4.84	0
$M_{Bw} = \sqrt{(M_{Tx})^2 + (M_{Ty})^2}$ = 4152 ·Q in.lbs	C	3.61	4.84	2.58
·Q in.lbs				

S_B at any point (P) = M_B at that point · $\frac{r}{I}$

$\frac{r}{I} = \frac{3.644}{33.14} = \frac{.11}{2I}$, $\frac{c}{2I}$ = .055

Engineer WSK

Date 8-1-46

Fig. 10

The method and procedure for the calculation of the forces, moments, and stresses in this type of configuration are the same as for other types having all lines of like moments of inertia, with the exception that it will be necessary to adjust the various pipe lengths so that they will be equivalent in flexural properties to one particular size and weight.

Comment on Flattening Theory

If the flattening theory, which has generally been accepted as applying to 5 diameter pipe bends, is also applicable to 1½ diameter welding ells, and that theory incorporated into the accompanying computations, the reactions and stresses will have somewhat different values. The forces and moments will be reduced from 20 to 25 per cent. The bending stresses in the straight pipe at O and C will be about 20 per cent less, but the stresses developed in the ells according to the theory will be about 25 per cent in excess. This increase is due to the necessity of applying the longitudinal stress multiplication factor beta (β), which in this instance is 1.76.

It is the author's opinion based on his observations of the performance of welding ells when welded into assemblies both on the test floor and when in actual service, that the welding ell contributes no more flexibility to a piping configuration than does the equivalent amount of straight pipe. In fact, tests indicate that pipe can be stressed to such an extent that a permanent set will occur, while the welding ell exhibited no deformation due to flattening.

The circumferential butt weld with its 1/16 in. to ⅛ in. weld reinforcement or overlay, especially when a backing ring is used, tends to restrict any flattening. Consideration must also be given to the fact that a 12½ per cent thinning of the pipe wall is permissible, due to allowable mill tolerances, whereas the wall thickness of the welding ell is generally nominal and in some instances over nominal.

The common practice in the manufacture of welding ells is to increase the metal thickness at the throat or crotch, to compensate for the increase in stress along the inner radius; this tends to increase the moment of inertia and to resist any flattening.

At the annual meeting of the Steel Boiler Institute, Inc., the following officers and directors were elected: President, J. R. Collette, Titusville Iron Works Co.; vice president, L. N. Hunter, National Radiator Co.; secretary and treasurer, R. A. Locke.

The directors comprise P. K. Addams, Fitzgibbons Boiler Co.; J. F. Johnston, Jr., Johnston Brothers; E. M. Palmer, Kewanee Boiler Corp.; and H. B. Stoygall, Pacific Steel Boiler Div.

The headquarters office of the institute has been transferred from New York to Philadelphia, in the Land Title Building.

The South has remained principally an agricultural economy due to climatic reasons

Predicts Great Importance for Air Conditioning in the South

William B. Henderson, Executive Vice President of Air Conditioning and Refrigerating Machinery Association, Says in Report to ACRMA's Board of Directors That Wider Use of Air Conditioning in the South Can Do Much to Promote Manufacturing and Will Help to Raise the Level of Education

THE AIR CONDITIONING and refrigerating industry faces unusual prospects during the years immediately ahead because of the increasing demands for commercial and industrial applications, including plans to incorporate air conditioning in most new office buildings, stores, hotels and other commercial construction and renovation; because of the expanding field of home air conditioning; and especially because of the varied and numerous new and imperative uses for refrigeration and air conditioning developed both out of the normal progress of industry and the accelerated production of the war period.

There are two important phases of this enlarged use of the industry's products which will be discussed more fully: One is the growth of southern manufacturing, to which both air conditioning and refrigeration are making outstanding contributions; the other is the part air conditioning can play in increasing school attendance and raising the level of education in the South. This is of high importance at this moment because plans are now being formulated for the construction of a large number of public and high schools, a work which undoubtedly will begin as quickly as materials are made available.

One of the most significant trends in manufacturing in progress at this time is the industrialization of the South. This trend gained impetus during the early years of the war and has continued with such rapidity that it commands increasing attention in our concept of industrial America. The progress of the South is important to all business, but doubly so to the air conditioning and refrigerating industry which has played such a large part in making northern manufacturing and processing techniques adaptable to the southern climate.

For many generations the South has remained largely an agricultural economy. A change began to occur even prior to the first World War, and while gradual it was none the less fundamental and consistent until accelerated still further by the more intense demands of the last war. It is a fortunate and, indeed, an imperative transition. More and larger industries for the South seem to be the only answer to the problems that spring from rapid mechanization of southern agriculture, which is now well under way with the introduction of the mechanical cottonpicker, the flame cultivator and other labor saving farm equipment. A large rural population, accustomed to obtaining a livelihood from the planting, hoeing, and picking of cotton, will not be needed in such numbers in mechanized cotton production. It must turn to industry, either by migration to the North or, if the development of southern industry keeps pace, to the new factories that will be established in the southern cities.

The South has remained principally an agricultural economy due to climatic reasons. The situation has been similar around the globe. Industry probably had its beginning in the warmer climates. But as fire was harnessed and heating was developed, industry came to be most heavily concentrated in the temperate zones. This has not been merely a matter of availability of raw products. Tropical products — rubber, sugar, cocoa, and numerous others —have been taken north for processing, and reshipped south for con-

sumption. Even the products of the warmer areas of the temperate zone —such as cotton itself—were for a long period made into finished articles largely in the northern part of this country and Europe. Heating—the control of cold—has been the outstanding reason for the greater industrial development of the cooler regions of the Americas and the Old World. Workers are more alert and efficient and tire less easily in an environment of balanced temperature and humidity. There are few places in the world that offer a climate that is conducive throughout the entire year to the greatest human efficiency. Excessive heat and high humidity cause fatigue and impair efficiency. Irritability, tension, physical and mental lethargy, and lower production are natural results.

"Most Significant Development"

Now, with the introduction of industrial air conditioning, heat can be controlled just as readily as cold. This is one of the most significant developments for the South in its economic history, probably equalling or exceeding in its importance the invention of the cotton gin. It means that instead of being retarded industrially by climatic conditions, where in fact the heat has been a disadvantage for a matter of only a few months in the year, the South is suddenly placed in a position of full equality or advantage from a climatic standpoint.

Inside factory and office temperatures and humidity can be controlled exactly as desired during the hot summer months. For the balance of the year the South possesses an ideal industrial climate. Heating is not so much of a problem or expense during the winter season. Factory working conditions in the South are brought at least to a level of those in the industrial centers in the North. It was demonstrated during wartime manufacture that under controlled temperature and humidity conditions in the plants, southern industry could readily compete in output and the quality of the goods with the industry of the North. There is no sectional advantage when working conditions are the same.

The South has an abundance of the raw materials upon which all industry depends, and is nearer to the varied resources of the tropics. It is an advantageous position, geographically, for distribution of finished products. The South is the remaining industrial frontier of this country—but it is a frontier that will vanish quickly, due in no small part to what the air conditioning industry is able to contribute toward improved working conditions and greater efficiency to the individual workman. We can look ahead to the development of southern manufacturing in the next decade as one of the outstanding chapters in the whole history of American and perhaps of world industry. The North should benefit from this transition also, because southern purchasing power will be materially increased. The economic advancement of one section should mean the opportunity for greater productivity and improved standards of living for the whole country.

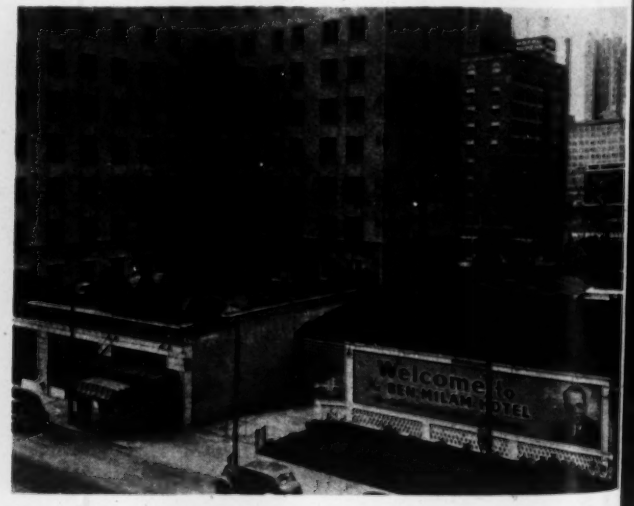
It is to be remembered in this connection that the uses for air conditioning and refrigerating machinery by other industries were extended rapidly under the impetus of war. Perhaps the larger number of earlier installations of this equipment involved improvements in existing buildings and factories. But during the war, and especially in the large war plants built in the South, many large scale installations of air conditioning and refrigerating machinery were made as integral parts of the factory buildings at the time of their construction. Large, modern manufacturing plants were built and furnished in the most efficient methods. This gave a picture of the uses of the air conditioning and refrigerating industry's products much more clearly than was possible in most of the pre-war plants, where the incorporation of new methods was brought about by plant alterations and modifications, and where most of the old type of building design had to be retained.

Construction Economies with Air Conditioning

One misconception about air conditioning has been that it involved an expense that was altogether additional, and substantial in amount. For example, most office buildings have been planned in such a way as to give the max-

Fifty-four 75 hp radial compressors and six 20 hp compressor units provide refrigeration for maintaining this plant in Georgia at 78 F

This hotel in Texas is completely air conditioned with a 130 ton central station system



imum number of outside and corner rooms. Ventilation has been a prime consideration. With air conditioning there is little premium on corner rooms and outside area space. Air circulation is well cared for. This makes it possible to build in the form of an unbroken rectangle, saving much wall space and bringing down costs, as well as conserving ground space. One new hospital, capitalizing on this simplification of design, has reported that the construction costs including air conditioning would be actually lower than those of hospitals with the same number of beds which had been built along conventional lines.

Experiences with the modern factories constructed during the war and especially those in the South, which were less often conversions of older plants, point to the fact that where air conditioning is installed as an integral part of a building at the time of its construction, there is possibility that it will offer little added expense and, in any event, important compensating savings. Like plumbing and electricity for modern homes—once considered expensive—air conditioning is becoming for many industries a built-in necessity rather than a superimposed convenience.

New plants are going up in the South, having two way temperature control for the comfort of employees and for the processing needs of many products. Here air conditioning and refrigeration are not conveniences by which certain jobs and processes merely can be carried on more comfortably, but are basic parts of the modern factory where top efficiency and top performance are necessary to survival. In its new period of industrialization, the South has an unusual opportunity, and an advantage in some respects, to plan its plants to incorporate the latest technological progress, and to do so at the lowest possible cost.

Air conditioning and refrigeration are suggesting also the development in the South of industries long assumed to require northern conditions and which, in some instances, were regarded as seasonal even in the North. This is of importance in considering the long term opportunities for service and market expansion possessed by the air conditioning and refrigerating industry. Air conditioning has made possible the high speed and uniform production of textile mills which weave woolens or cotton, and the new synthetic textiles could not be produced in quantity and quality without it. In pharmaceuticals, precision instruments, printing and other paper work, metal working and assembly, high speed industry, and numerous other lines, air conditioning has put the South on a basis of full equality with the North.

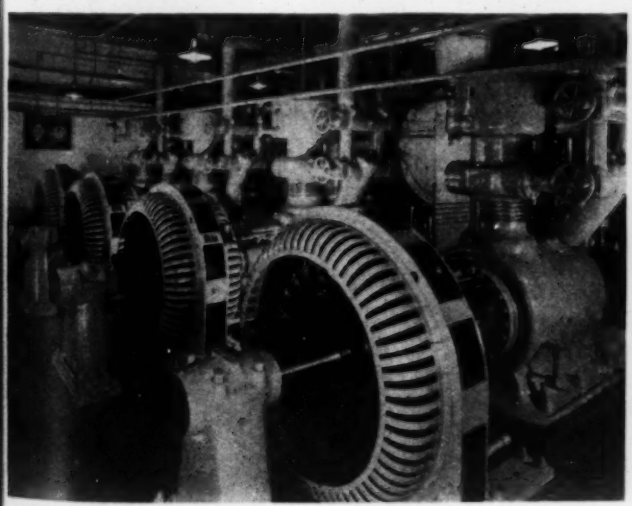
In the midst of its economic and industrial conversion, the South also is giving serious consideration to its educational facilities. It is possible to look at some generally known facts and from them gain something of a broad picture of the service this industry may perform in the schools of the southern and warmer sections of the country.

Improved Educational Facilities

All are familiar with the fact that illiteracy is more common in some of the southern than in northern states. There are various reasons for this condition. For instance, the economic value of children—and especially boys—is high in an agricultural economy where they can be of definite help to the family in its work. It is a situation which has long existed in parts of the South, and has caused the withdrawing of children from school at an early age.

In recent years this practice has been decreased to some extent, and the percentage of persons between the ages of 5 and 24 attending school is only about 5 per cent lower in southern states than in the northern and midwestern states. However, this probably is not a true index of the situation. For instance, the number of days in the school term varies as much as 50 between state averages. There is similarly a great discrepancy in the number of days in a school year between rural and city schools. Nor is attendance uniform throughout the country. One report which has come to my attention, made before the war, showed that Mississippi schools were open an average

Four ammonia compressors furnish refrigeration for air conditioning two large Tulsa buildings



Air conditioning is used to control conditions for grinding lenses at this West Virginia optical company

of 132 days a year, while New Jersey schools averaged 186 active days. The difference in educational opportunities becomes even greater when the attendance record is shown, with Mississippi students averaging 98 days of schooling per year against 166 days for the average Ohio pupil. At this rate an Ohio student who had completed the fifth grade actually had spent more time in school than a Mississippi pupil who had graduated from the eighth grade.

While there may be other factors which have led to the shorter school year noted in parts of the South, the hot weather of late spring and early fall most likely would reduce school attendance and the actual learning value even if the schools were kept open for a longer period each year. Everybody knows that it is more difficult to study in hot weather. Lengthening the school year in the South can do little to reach the seat of the problem unless indoor weather conditions promote attendance and attention.

Substantial Educational Progress

The faculties and school boards of the South have accounted for substantial educational progress in the last few decades. Whereas the illiteracy of persons over the age of 20 in the state of Georgia was about 4.1 per cent, according to pre-war figures, the illiteracy of those between the ages of 10 and 20 was only 1.7 per cent. In Tennessee the difference is even greater, with an illiteracy rate of 6.6 per cent in the older age group and 2.5 per cent in the younger. This is a recovery of over 4 per cent.

While it is obvious that the bare standards of a literacy test cannot measure the higher degree of learning required for more useful citizenship, it can be assumed that similar if not longer strides have been taken in this respect. The improvements in southern compulsory education have been rapid and progressive, in spite of the handicap imposed on the teachers, administrators, and school boards by the warm climate. Unquestionably, one of the largest single obstacles to greater educational advancement in the deep South lies in the physical conditions under which the faculty and pupils must work. Already school boards and parochial schools are laying plans for air conditioned buildings, and it now seems extremely likely that the first completely air conditioned schools will be in the South, on the theory that the study conditions of future citizens is of at least equal importance with the working conditions in industrial plants.

Air Conditioned School Will Be Common

We all know, of course, that there is no royal road to learning. But keeping in mind what is happening right now in industry, it is safe to predict that the air conditioned school will become a commonplace in the South. Better school room conditions will naturally lead to higher scholastic standards, and we can forecast freely that in the air conditioned school, the attendance records will make better reading. Introduction of air conditioning to the classroom should make practical the extension of the school year to allow the southern student as many days of actual study during the year as are offered the pupils in cooler sections of the country. This would greatly reduce the time handicap under which the southern teacher must work. As to reducing non-attendance, it has been found in many factories and office buildings that installed air conditioning that absenteeism has decreased. And the same results most likely would be forthcoming in the schools.

Even during the shorter term now used in most southern schools, the heat and humidity are often beyond the comfort zone. When the body is uncomfortable the mind has greater difficulty in concentrating. Excessive heat and humidity tend to make the individual irritable or sleepy, and these characteristics in either teacher or the pupil are disastrous to learning.

Great advances have been made in teaching techniques and the physical conditions of the schoolroom. The foremost educators of the country have labored diligently on visual teaching methods and simplified presentations. Modern schools have more comfortable chairs, better desks, adequate lighting, and a host of other things. But the problems of better conditioning of the air—controlling humidity, air cleanliness, and circulation, are only now the subject of study and correction.

The immediate importance of this from the standpoint of the air conditioning industry is that a great many schools will be built in a relatively short time, or as soon as the more immediate demands for housing are met. These schools must be planned and appropriations for their construction must be made. It will be a great advantage—and, in the end, a distinct economy—if provisions for air conditioning are incorporated as an integral part of the building design. Therefore the industry should do all it can with appropriateness to bring this question fully to the attention of educators in the South, in order that they may make their own investigations and determine for themselves the contributions that air conditioning is in a position to make to the educational advancement of this section of the United States.

WHAT BECOMES OF MELTED SNOW?

THE EDITOR — In the answer by "E.W." to the question about snow melting coils published on page 102 of the September HPAC, he was concerned about how to get rid of the snow after it had been melted. I'd like to ask him what becomes of any snow that melts on a sidewalk, forming a puddle one day but disappearing the next? The answer is that the water evaporates.

I have observed that where central heating plant piping tunnels are paved for use as walkways that the walks are always dry, and there are no puddles nor any special drainage arrangements for the melted snow.

It all boils down to this, that evaporation does not begin or stop at a boiling point.—H.B.K.

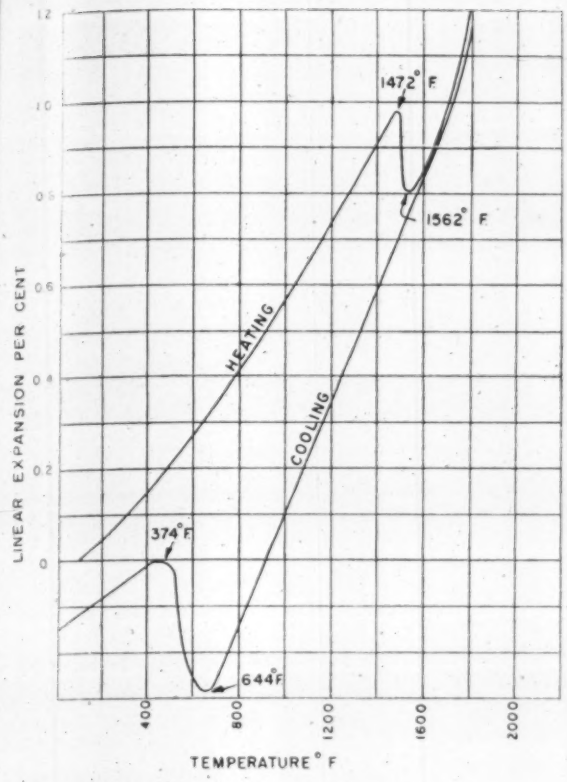


Fig. 1—Dilatometer curve on 12 per cent straight chromium steel. The suppressed transformation on cooling occurs at a relatively low temperature when the metal is no longer plastic.

WELDING Alloy Steel PIPING

Eric R. Seabloom Discusses Methods for Welding Straight Chromium Steels

A TREND toward higher alloy steels for piping can be expected, as operating conditions are continuously becoming more exacting with the development of various industrial processes. Most of the alloys used are not as weldable as the plain carbon steels, but they can be successfully welded if the proper procedures are employed. In the October HPAC Mr. Seabloom, who is supervising engineer, Crane Research Laboratories, dealt with the chromium-molybdenum steels, and this month he takes up the more difficult straight chromium steels. His article is reproduced from Valve World.

WELDING has been used extensively in the fabrication and erection of piping for many years. This mostly included mild carbon and low alloy steels, which are comparatively easy to weld. Since the operating conditions are continuously becoming more exacting with the development of various industrial processes, wherein piping is involved, the trend towards higher alloy steels can be expected.

While most of these alloys are not as weldable as the plain carbon steels, they can be successfully welded by various welding processes, provided that proper procedures are employed. A better understanding of the characteristics of the materials will aid in establishing suitable techniques. An article last month dealt with the not too difficult chromium-molybdenum alloy steels. This second article deals with the somewhat more difficult straight chromium steels, and a third article will cover the chromium-nickel stainless types.

There are several types of straight chromium steels available having various chromium and carbon ranges, with some grades containing small percentages of nickel, tungsten, molybdenum, aluminum or selenium. Table 1 lists only typical types from the American Iron and Steel Institute classifications.

These steels are primarily used on high temperature service where resistance to corrosion and oxidation is desired. They are usually employed in oil refinery and chemical process work.

Characteristics Pertinent to Weldability

From the welding standpoint the straight chromium steels can be divided into two general groups, the hardening (martensitic) and the non-hardening (ferritic). Those in the martensitic group, of 10 to 14 per cent chromium content, are decidedly air hardening and display marked suppressed transformations upon cooling. Steels in the ferritic group, of 18 to 30 per cent chromium content, do not harden even when cooled rapidly from the welding heat, since, with normal carbon contents, they generally have no critical transformations.

Between these two groups, there is a range of 14 to 18 per cent chromium steels that are partly martensitic and partly ferritic. Their behavior depends upon the chromium content with respect to the amount of carbon. As an illustra-

Table 1—Straight chromium steels for high temperature service

AISI type	Carbon content	Chromium range
410	0.15% max.	10.00 to 14.00
430	0.12% max.	14.00 to 18.00
442	0.35% max.	18.00 to 23.00
446	0.35% max.	23.00 to 30.00

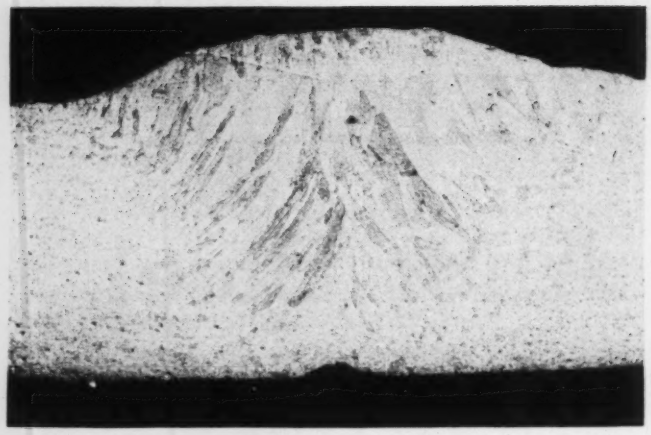


Fig. 2—Macrograph of weld in 27 per cent straight chromium steel tubing. Deposited weld metal is of similar analysis. Weld was made without preheat but was stress relieved at 1450 F. Note the large elongated dendritic grains resulting from the welding heat.

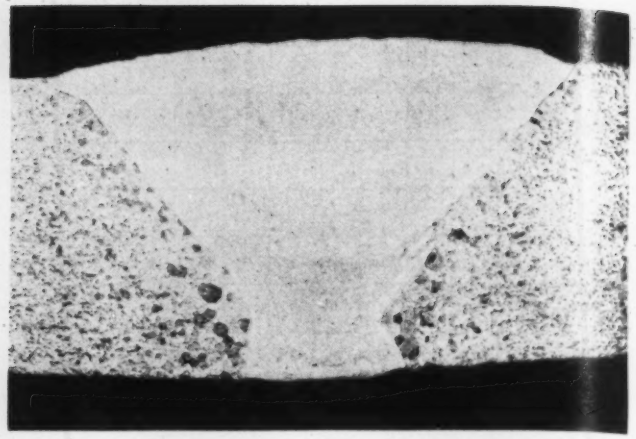


Fig. 3—Macrograph of 25-20 chromium-nickel weld in 27 per cent straight chromium steel tubing. Preheat of 450 F was employed, which broadened the heat affected zone and increased the grain size in the adjacent parent metal.

tion, a 16 per cent chromium steel with low carbon content will display less hardening than 16 per cent chromium with higher carbon. Generally speaking, the 14 to 18 per cent chromium steels do not harden to as great an extent as the 10 to 14 per cent chromium, nor do they develop grain growth with resultant brittleness, as is the case with 18 to 30 per cent chromium steels. However, there is no distinct line of demarcation in behavior of this group; that is, the lower chromium content steels will act similar to the martensitic grades and the higher chromiums will display characteristics somewhat like the ferritic types.

As previously mentioned, the 10 to 14 per cent straight chromium steels are air hardening similar to the lower chromium molybdenum grades and are also very sluggish in transforming from the welding heat, as illustrated by Fig. 1. Thus, it is essential to employ relatively high preheats, the temperatures ranging from 300 to 600 F and even higher, depending upon metal thickness and design of weldment. Heat treatment is necessary, preferably as soon as possible after welding.

In the 14 to 18 per cent chromium group, the narrow range of 15 to 16 per cent chromium is an important one, since it is highly resistant to nitric acid service and is the least difficult to weld of the straight-chromium steels. Preheat of 300 F is usually sufficient, and, although heat treatment is necessary, it need not follow immediately after welding.

The range of 16 to 18 per cent chromium steels in the 14 to 18 per cent chromium group approach the nature of the higher chromium ferritic steels in that they suffer a reduction in impact strength and ductility due to grain growth and are usually non-air-hardening. Preheating at 300 F is generally employed. Since the coarse grain structure cannot be refined by heat treatment, stress relieving is often resorted to in order to reduce the danger of weld cracking.

The 18 to 30 per cent chromium steels, and particularly the 23 to 30 per cent range, are primarily employed for resistance to oxidation at elevated temperatures. They are also used in catalytic refining installations instead of the more weldable chromium-nickel stainless steels, because nickel is believed to have a deleterious effect on certain processes. Welds are ductile at high temperatures, but very brittle at room temperature. These alloys are entirely ferritic and generally without critical points. Therefore, with the exception of mechanical working, there is no possibility of refining coarse grain growth which results from welding temperatures (see Fig. 2). The question of preheating the 18 to 30 per cent chromium steels is a controversial issue. Some authorities recommend 300 F while others suggest temperatures as high as 900 F. Recent investigations indicate that preheating regardless of the type of deposited metal used, tends to broaden the adjacent heat affected area of the parent metal, cause larger ferrite grains, produce greater precipitation of a brittle constituent and reduce the tensile strength, yield point, ductility, and impact values. It is suggested that preheating be eliminated but caution should be exercised and experience should dictate the preheating procedure, since the higher chromium steels are usually brittle below 200 F.

Sometimes the straight chromium steels are welded with 25-12 or 25-20 austenitic chromium-nickel stainless steel filler metal (see Fig. 3). However, caution should be used in applying dissimilar metals. The coefficient of thermal expansion of the 25-12 or 25-20 chromium-nickel steels is approximately 50 per cent greater than the straight chromium steels, and due to this difference high stresses may be set up during repeated heating and cooling in service resulting in eventual failure of the welded joint. Stress corrosion may be encountered. The heat affected zones in the parent metals adjacent to the welds, although quite narrow, will be brittle. Proper annealing heat treatments of the chromium-nickel welds and the straight chromium parent metals differ in that the chromium-nickel requires higher temperatures for annealing than those recommended for some of the straight chromium steels. In other words, a suitable heat treatment for one may ruin the other. Furthermore, carbide precipitation and inferior corrosion resistance of the austenitic weld deposits may result when annealing in accordance with rec-

ommended procedures for the straight chromium steels.

Probably the best method of welding the 23 to 28 per cent chromium steels is to employ 25-12 or 25-20 chromium-nickel filler metals, regardless of the cautions mentioned above, since it is about the only way of obtaining somewhat ductile welds in this most difficult group of steels to weld. But careful consideration should be given to the service requirements. (See Fig. 4).

When proper procedures of preheating, welding, stress relieving or heat treatment are followed, the welds in straight chromium steels will meet the requirements of the ASA Code for Pressure Piping on procedure and qualification tests.

Gas Welding

The oxy-acetylene flame can be employed in welding the straight chromium steels if certain precautions are adhered to, but there are some limitations, especially in the higher chromium types. Weld rods of proper analysis are not always available and, as explained in the first article, flame adjustment is important. Suitable fluxes are also necessary to dissolve the chromium oxides.

Since the thermal conductivity of the straight chromium steels is about 50 per cent less than the plain carbon steels, heat is retained longer and a smaller flame is, therefore, recommended to reduce the possibility of overheating and boiling of the metal. On the higher chromium steels excessive heating results in grain growth with impairment of ductility in the adjacent base metals. As it is practically impossible to prevent excessive grain growth with oxy-acetylene welding in the 23 to 30 per cent chromium steels this process is not used extensively for these ferritic alloys.

Welding rods should contain slightly higher chromium, manganese, and silicon than the base metal to allow for reduction of these elements in the welding flame.

Preheating of the adjacent base metals to be welded at temperatures as described above under "Characteristics Pertinent to Weldability," is generally accomplished by means of the welding blowpipe. Heat treatment is covered in a later paragraph.

Welding grooves recommended are the single vee butt joints, the fillet or socket joints, as shown by the sketch on page 70 of the October HPAC, and also the nozzle weld grooves shown in Fig. 5. Socket type fittings may not be available in all grades of these alloys. Welds can be made in all positions.

Brazing or Soldering

Brazing or soldering is not generally employed, since the straight chromium steels are primarily used at elevated temperatures or in corrosive media and the joining materials do not possess the high temperature properties or the corrosion resistance of the parent metals.

Atomic Hydrogen Welding

The straight chromium steels can be welded by the atomic hydrogen process, but it is not extensively used in the welding of piping. It is best adapted to the lighter pipe wall gages and to the lower chromium ranges. No flux is required since the hydrogen atmosphere around the arc stream helps to reduce the chromium oxides. The bare welding rod should be of about the same chemical composition as the base metal, except possibly slightly higher carbon content to compensate for the loss encountered in welding.

In the 18 to 30 per cent chromium grades the heat from the arc and hydrogen flame tends to overheat the deposited, as well as adjacent parent metals, resulting in excessive grain growth with consequent lowering of ductility.

Preheating of the base metals to temperatures previously described is usually adequately supplied by the process itself. Weld-

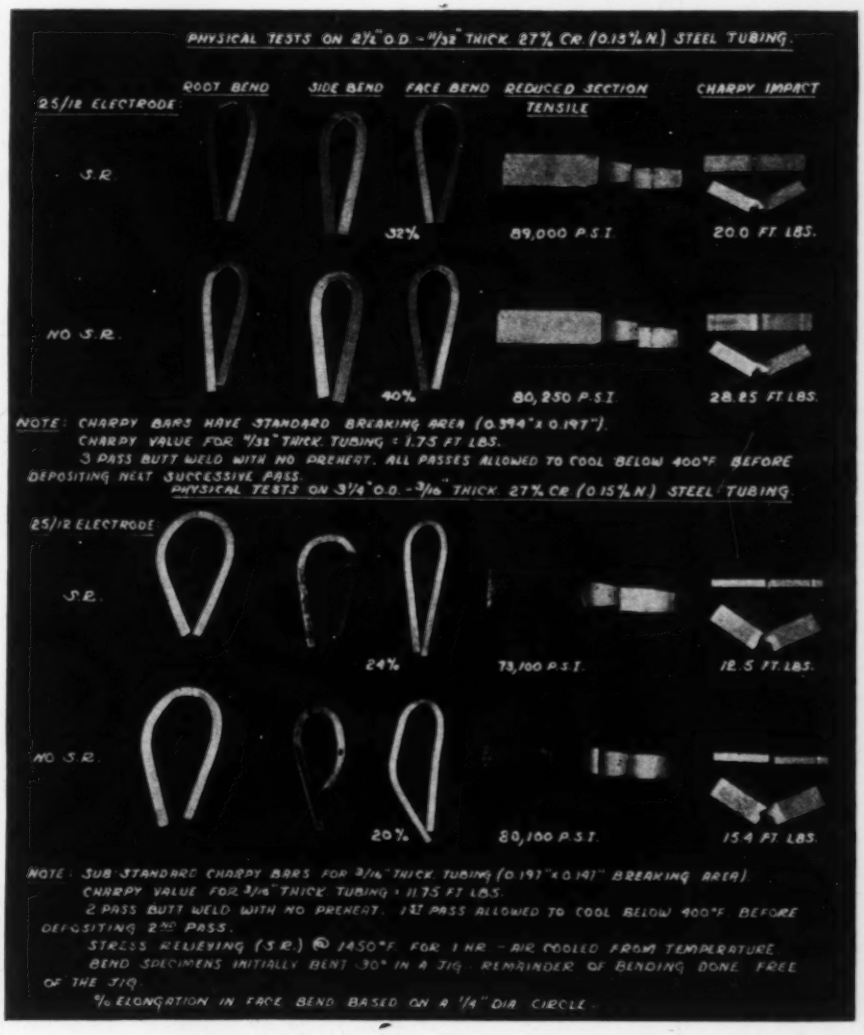

PHYSICAL TESTS ON 2½" O.D. - 11/32" THICK 27% CR (0.13% N) STEEL TUBING.
ROOT BEND
SIDE BEND
FACE BEND
REDUCED SECTION TENSILE
CHARPY IMPACT
25/12 ELECTRODE
S.R.
32%
89,000 P.S.I.
20.0 FT. LBS.
NO S.R.
40%
80,250 P.S.I.
28.25 FT. LBS.
NOTE: CHARPY BARS HAVE STANDARD BREAKING AREA (0.394" x 0.197").
CHARPY VALUE FOR 11/32" THICK TUBING = 1.75 FT LBS.
3 PASS BUTT WELD WITH NO PREHEAT. ALL PASSES ALLOWED TO COOL BELOW 400°F BEFORE DEPOSITING NEXT SUCCESSIVE PASS.
PHYSICAL TESTS ON 3¼" O.D. - 3/16" THICK 27% CR (0.15% N) STEEL TUBING
25/12 ELECTRODE
S.R.
24%
73,100 P.S.I.
12.5 FT. LBS.
NO S.R.
20%
80,100 P.S.I.
15.4 FT. LBS.
NOTE: SUB STANDARD CHARPY BARS FOR 3/16" THICK TUBING (0.197" x 0.197" BREAKING AREA)
CHARPY VALUE FOR 3/16" THICK TUBING = 11.75 FT LBS.
2 PASS BUTT WELD WITH NO PREHEAT. 1ST PASS ALLOWED TO COOL BELOW 400°F BEFORE DEPOSITING 2ND PASS.
STRESS RELIEVING (S.R.) @ 1450°F FOR 1 HR. - AIR COOLED FROM TEMPERATURE
BEND SPECIMENS INITIALLY BENT 30° IN A JIG. REMAINDER OF BENDING DONE FREE OF THE JIG.
% ELONGATION IN FACE BEND BASED ON A 1/4" DIA CIRCLE.

Fig. 4—Physical tests on 25-12 chromium-nickel welds in 27 per cent straight chromium tubing. All bend specimens display good ductility in both the "as welded" and stress relieved conditions. Impact values lower when stress relieved.

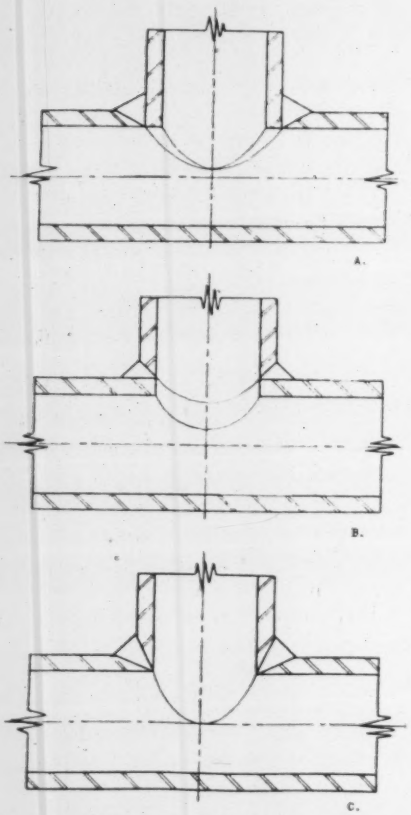


Fig. 5—Welding grooves for nozzles.

ing grooves such as the above mentioned single vee butt joints, fillet or socket joints, and nozzle joints, are recommended, but welding should preferably be in the downhand position. Heat treatment is described in a later paragraph.

Metallic Arc Welding

Metallic arc welding is the most widely used process in joining the straight chromium steels and produces the most favorable results. Generally the process provides close control of the carbon content, coatings on the electrodes protect the arc stream of molten metal from the gases in the atmosphere and also compensate for chromium losses, and the highly localized heat narrows the heat affected zones in the parent metals, unless very high preheats are employed. The danger of excessive grain growth in the ferritic type of base material and boiling of the deposited metal is materially reduced.

Coated electrodes giving the same analysis of the deposited metal as the base materials are generally available and should be used, excepting with the 23 to 30 per cent ferritic chromium types where 25-12 or 25-20 austenitic chromium-nickel electrodes are preferred.

On such occasions when it is detrimental to have chromium-nickel welds exposed to certain internal fluids, welds can be made by using 23 to 30 per cent straight chromium filler metal for the first pass with subsequent passes of 25-12 or 25-20. However, it is recommended that the cautions mentioned previously be given careful consideration.

Welds can be made in all positions, but downhand work is preferred. The electrodes used are generally smaller in size than those employed on plain carbon steel and seldom exceed $\frac{3}{16}$ in. in diameter. The types of welding grooves recommended for arc welding are the single vee butt joints, with or without backing rings, and the lap or socket joints, illustrated by the sketch on page 70 of the October HPAC, and the nozzle joints shown in Fig. 5.

Some of the straight chromium steels require preheating at temperatures suggested under "Characteristics Pertinent to Weldability" which is a separate operation of great importance, particularly with the air hardening grades, as it retards the cooling rate and prevents weld cracking. Preheating can be accomplished by oxy-acetylene torches, suitable gas burners, electric induction coils or electric resistance coils. Heating should be gradual and uniform with the temperatures maintained during welding operations.

Heat Treatments

Heat treatments of piping assemblies in the straight chromium alloys generally consist of annealing or stress relieving. The treatment depends upon the service requirements, grade of base metal, type of filler metal, shop or field fabrication and furnace equipment involved.

The 10 to 14 per cent chromium range when welded with filler metal of similar analysis should be annealed at 1550-1650 F and furnace cooled at least to 1100 F. Another treatment, which can also be used if this type of steel is welded with 25-12 or 25-20 chromium-nickel austenitic stainless filler metal, is by heating to 1[illegible]00 F, followed by slow cooling. The heat treatments should preferably be made as soon as possible after welding.

The 15 to 16 per cent chromium steel when welded with 15 per cent chromium filler metal should be annealed at 1450-1550 F and furnace cooled to at least 1100 F. If welded with 25-12 or 25-20 chromium-nickel austenitic filler metal, stress relieving at 1400 F, followed by slow cooling may reduce the hardness of the heat affected zones in the parent metal sufficiently to be satisfactory for some applications.

For the 16 to 18 per cent chromium steel, when welded with either 18 per cent chromium, 25-12 or 25-20 chromium-nickel filler metal, stress relieving is usually sufficient, as this alloy does not respond well to heat treatment. Heating to 1450-1500 F followed by air cooling will relieve the residual stresses.

The 18 to 30 per cent chromium ferritic steel, when welded with filler metal of similar analysis, usually requires heating to 1600-1650 F for a considerable length of time followed by rapid cooling in order to obtain maximum ductility. However, even with such treatment, the welds will be quite brittle and may not be satisfactory for most service conditions. Furthermore, quite often a treatment of this kind is not practical. When welding is done with 25-12 or 25-20 chromium-nickel filler metal, stress relieving at 1450-1500 F gives somewhat better results. On light wall thicknesses, stress relieving may even be dispensed with, since recent tests have shown that the ductility is not affected but that the impact strength of austenitic welds is lowered by stress relieving.

Stress relieving can either be done in a heat treating furnace or by local means, employing gas burners, clamp-on gas fired furnace, electric induction or resistance coils. The width of the circumferential band incorporating the weld at the center, which is to be heated to the desired temperature, should be equal to at least twice the width of the weld. Beyond this zone the temperature should diminish gradually.

INCREASES FIGHTING EFFICIENCY

Navy Plans to Air Condition All Its Major Combatant Ships

All Living and Working Compartments Except Machinery Spaces Aboard New Cruisers To Be Equipped; Cooling Permits More Restful Sleeping, Aids Health, Efficiency

AIR CONDITIONING systems are being installed in two new Navy cruisers under an experimental program designed to increase the fighting efficiency of naval personnel and to improve living conditions aboard ships of the fleet.

The Navy has made increasing use of shipboard air cooling equipment for more than 40 years, culminating in the experimental installations now being made aboard the 17,000 ton heavy cruisers Salem and Newport News. Except for the machinery spaces, virtually all living and working compartments aboard the new cruisers will be air conditioned.

Vice Admiral E. L. Cochrane, USN, chief of the bureau of ships, emphasized that the Navy "is not trying to mollycoddle its personnel." "Admittedly the ships will be more comfortable in tropical climates, but that consideration is not paramount. It is to improve the battle effectiveness that this is being done," he explained.

Citing wartime experience, Admiral Cochrane said "the fighting efficiency of our fleet is lowered in proportion to the human strain and exhaustion caused by exposing personnel to long periods of abnormal heat. There can be no question but that the crew in an air conditioned warship will have a distinct and perhaps a decisive advantage in action with an enemy fatigued and of lowered alertness from living in a ship that is not air conditioned."

Under the experimental program, two types of air conditioning equipment are being tested by the bureau. One, utilizing steam jet equipment, will be aboard the USS Salem when she is completed in late 1947. The USS Newport News, now under construction at Newport News and also scheduled for completion in late 1947, will have equipment utilizing high speed "Freon" compressors. Both cooling systems have a simplified Navy coil design which is shockproof and easily cleaned.

"This installation is experimental only insofar as the equipment itself is concerned," Admiral Cochrane noted. "The rigors of tropical warfare pose a tactical problem that can be solved only by air conditioning all of our major combatant ships in the future. For the present we are seeking to determine what type of equipment is most efficient for the purpose."

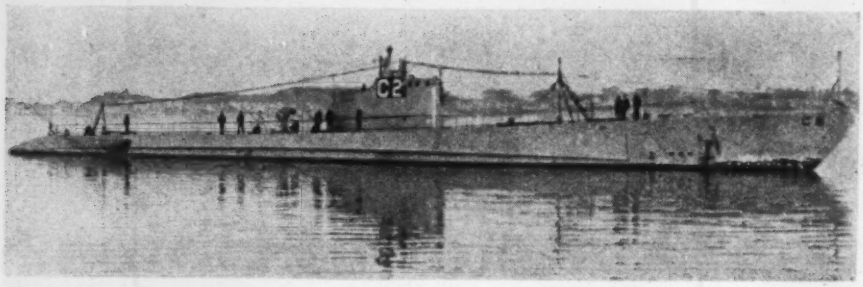
Extensive Experiments

The results of the first two installations, will be carefully studied and, together with space and weight factors, will decide the future application of either or both types of cooling equipment for combatant ships.

"Early reports from the South Pacific fighting fronts made it clear that heat exhaustion was a tactical factor in ship design," Admiral Cochrane added. "But even the tactical advantages of air cooled ships had to be weighed in the light of wartime labor and material shortages. The Jap's ships were not air conditioned either and we fought on equal terms in that regard. Other programs were accordingly given much higher priority in order to overcome the initial advantage gained by the enemy at Pearl Harbor."

Later in the war, the bureau of medicine and surgery, in cooperation with the bureau of ships, in-

Beginning with the Essex class in 1942, aircraft carriers were provided with mechanical cooling for the ready rooms



The USS Cuttlefish was the first submarine to have air conditioning installed during her original construction

vestigated the need for shipboard air conditioning and determined the technical requirements for optimum results. Its research clearly established that marked improvement in the efficiency and health of ship's crews would result from use of cooling equipment in living quarters, which would permit more restful sleeping and prevent certain skin ailments caused by heat and humidity.

Extensive experiments were conducted at the Naval Medical Research Institute, Bethesda, Md., and aboard the USS Franklin, aircraft carrier, on her shakedown cruise in the Caribbean.

The Bethesda tests, which simulated conditions on board a ship in tropical waters, were carried out on two groups of volunteers. Both groups worked in hot environments, but one group rested in hot quarters while the other rested in quarters cooled just below the sweating threshold temperature. The studies involved the measurement of 32 physiological and psychological functions. The examination of such diversified functions as sensorimotor performance, various aspects of vision, and the performance of physical work in the heat consistently demonstrated the superiority of the "cool" group.

It was concluded that the principal factor underlying the differences shown by the two groups was the amount of restful sleep. The men in cool quarters slept better, while almost without exception the men in the "hot" group developed heat rash which disturbed their sleep and reduced their efficiency the following day.

Twenty volunteers were selected for the experiments aboard the Franklin, and continuous measurements were made of the temperature and humidity in their berthing compartment during the cruise. As the ship moved into the warmer climate, almost all members of the crew complained of the heat, of broken sleep, and of feeling tired. Their work output was markedly less as the carrier reached the tropics.

It was concluded that mechanical ventilation, using supply and exhaust fans only, was incapable of producing and maintaining the physiologically acceptable level of 78 deg effective temperature, and that the cooling and drying of air was most desirable in the interests of higher operating efficiency for personnel aboard ships in tropical climates.

As a result of the research, the bureau of ships was authorized by the chief of naval operations to incorporate experimental air conditioning equipment in the two cruisers under construction.

Not More Than 78 Deg ET

With the cooling equipment, living and berthing spaces of the Salem and the Newport News will be kept at an effective temperature of not more than 78 deg. ("Effective temperature," is a term which represents the combined effect of temperature, humidity, and air movement upon the human body. For this new naval application, 78 was chosen as the maximum standard because it is the highest temperature at which a person can remain at rest without perspiring. It is equivalent to 85 F dry bulb at 50 per cent relative humidity. Without mechanical cooling, the tropical temperature for shipboard berthing spaces was found to run as high as 87 deg ET, which is equivalent to 95 F dry bulb at 60 per cent relative humidity.)

Although the Salem and the Newport News will be the first combat ships to have living quarters completely air conditioned, cooling systems aboard Navy ships are not an innovation. About 40 years ago, temperature control was introduced to safeguard powder in the waist magazines of the early dreadnaughts. The method, which contemplated keeping the air at 90 F by circulating it over a series of coils cooled by brine from the ship's refrigerating plant, was abandoned in later ships when it became possible to locate the magazines in places less exposed to machinery heat.

Certain battle stations which had to be completely closed to protect personnel and equipment from water, smoke, and chemicals—such as plotting and control rooms—were fitted about 20 years ago with mechanical cooling systems which became standard equipment. This apparatus regulated the temperature to 85 F using two series of coils, the first containing sea water and the second refrigerant brine.

Beginning with the Essex class in 1942, aircraft carriers were provided with mechanical cooling for aviators' ready rooms. The temperature maintained was 65 F, low enough to allow alerted plane personnel to stand by in heavy flying clothes. Later, when radar and combat air patrols insured earlier warnings of enemy attack, pilots could delay donning flying clothes until just before take-off. Consequently, the ready room temperature was raised to 78 deg ET.

Air conditioning in submarines also has been the subject of many years of experimentation. The USS Cuttlefish, commissioned in June 1934, was the first submarine to have air conditioning installed during her construction.

The USS South Dakota, commissioned in 1942, was the first ship to have air conditioned hospital spaces. This was necessary because the hospital area was located on the third deck near the waterline. During the same year, the bureau of ships proceeded to equip operating rooms and sickbays of all other ships with mechanical cooling. The USS Haven was the first hospital ship to have living quarters as well as hospital spaces mechanically cooled. After her completion in 1945, all other hospital ships were altered or built with air conditioning.

Question of the Month

Reports Many Advantages, Reasonable Cost for Snow Melting by Pipe Coils

Landis S. Smith, Engineer, Industrial Dept., Rochester Gas and Electric Corp., Gives Design, Operating Data on 1925 Installation

ONE OF HPAC's readers asked recently for design information on pipe coils used for snow melting and installed in sidewalks, driveways, parking areas, runways, etc. In addition to the various specific answers to these questions which have been published, Mr. Smith has prepared this discussion of what is believed to be the earliest installation of this kind. It serves the front and side walks at an office building in Rochester, N. Y., and has been found to have many advantages. Operating cost is reasonable, and runs about the same as the labor cost for snow removal.

POSSIBLY THE oldest installation of piping in the United States specifically designed for snow melting was made in 1925 at the new main office building of the Rochester Gas and Electric Corp., Rochester, N. Y. This snow melting equipment, using purchased steam service with hand control, has given very satisfactory and economical service during the past 20 years. When this installation was made practically no data were available on snow melting. The design was therefore based on practical engineering sense rather than theoretical calculations. No repairs have been required and the system has operated without any trouble to the staff of Building Manager Ray Myers. In fact, the access panels provided have never been used except for inspection.

The sidewalks at the north and east sides of this 10 story office building are kept in a very clear condition. Because (insofar as was known) it had never been done before at the time of construction, the management preferred not to install the 1½ in. wrought iron pipe coils directly in the concrete slabs; instead, they were placed just below the slab in the concealed ceiling space. The coils are supported by angles hanging on rods. As a result, the system is somewhat slow in operating to take care of quick storms. The practice is to leave the system on continually during very severe cold weather and probable snowy periods. The past two winters have brought unusually severe drifting snows; however, these sidewalks have easily been kept clear even when adjacent property sidewalks were covered 3 ft deep!

Typical appearance of walk having snow melting coils on a snowy day. Extra capacity would be provided at the ends on any future installation to handle snow from adjacent property.

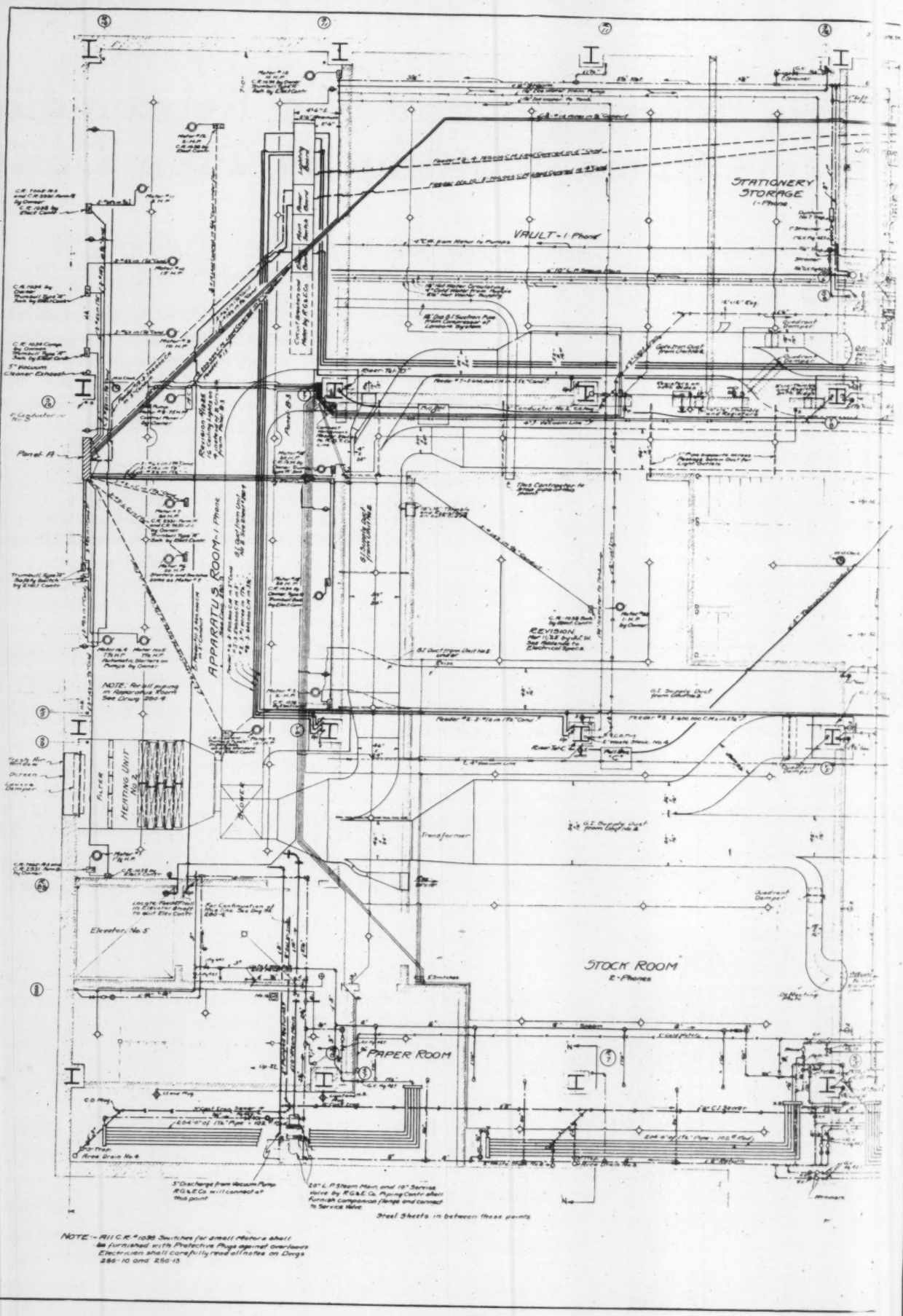
The walk along one side of the building is approximately 150 ft long by 7 ft wide, and the front sidewalk is about 110 ft long by 12 ft wide. The basement of the building extends under the sidewalks to the curb line along both sides.

The 1½ in. pipes form six-pipe grids, which are situated about 14 in. below the sidewalk surface. The insulated basement subceiling encloses the piping, which does not make direct contact with either ceiling or sidewalk. The long sidewalk is warmed by four of these six-pipe coils, each roughly 35 ft in length and placed end to end. The front sidewalk is heated by four coils, each 40 ft long, and one small coil about 16 ft long.

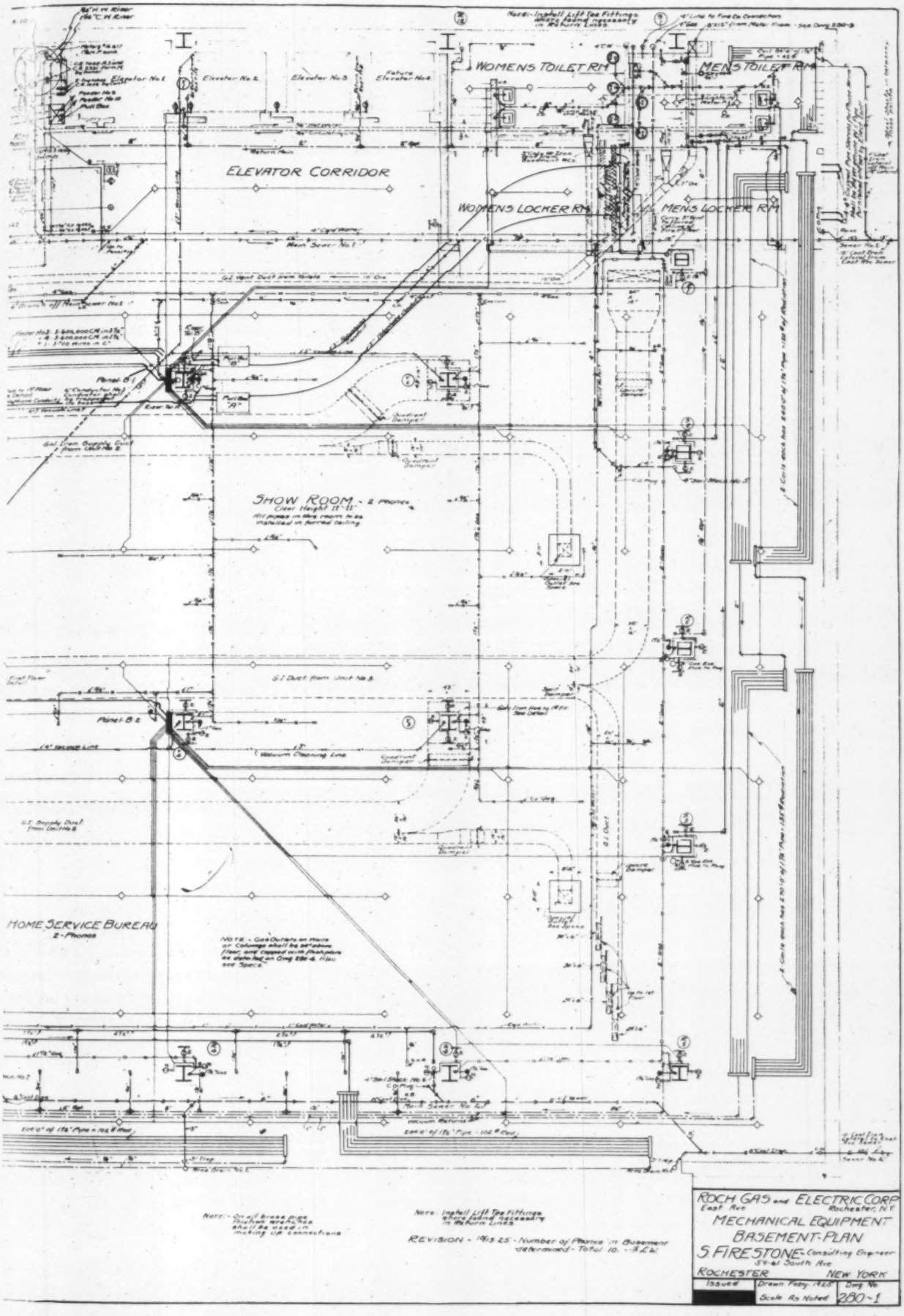
The operating cost is very reasonable on purchased steam service, running about the same as labor cost for snow removal in similar areas and being much more satisfactory. An average cold day (about 26 F) will require the use of around $5.00 worth of steam at 85c per 1000 lb by meter test.

Approximately 1 sq ft of pipe coil surface is used for each 2½ sq ft of sidewalk area, and practice has proved this to be ample capacity except at the extreme ends of the front sidewalk where some snow is carried over from adjacent property. The side coils have an area of 410 sq ft and the front coils have an area of 550 sq ft. This total pipe area of 960 sq ft uses about 6 lb of steam per sq ft of pipe area per day during the colder weather.

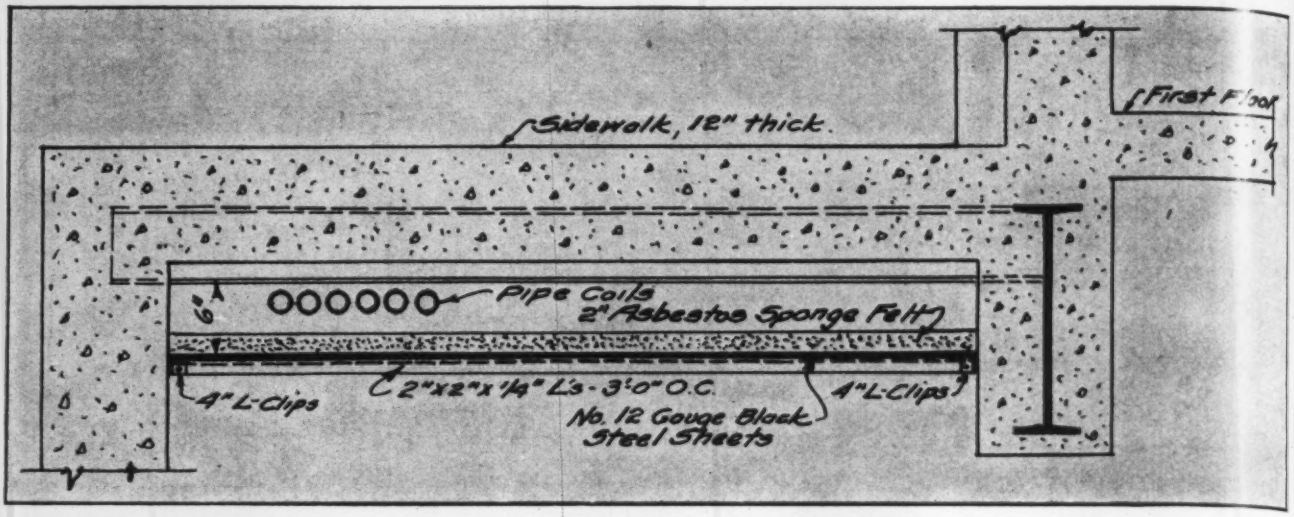
No detailed study has been made of the increased consumption due to snowfall as the sidewalks have a considerable heat storage effect and the steam is left on continuously during very snowy periods. Rochester has a normal of 6664 degree days. Nor-



Basement plan, showing



sidewalk snow melting coils



The coils are installed in concealed ceiling space

mal winter snowstorms average around 6 in. and the average winter has a total of 72 in. of snow. Last year's maximum snowfall was 24 in. in 24 hr!

Many Advantages

Snow melting has distinct advantages over shoveling. The sidewalks are continually kept clear—and. often, even dry—day and night. This has a definite customer goodwill value, makes the main show windows more accessible in the winter months, and provides a much safer walk for pedestrians.

In designing a new system we would, of course, install the pipe coils directly in the concrete slab as is the current practice in radiant heating. We would also install some additional heating capacity at the ends of the sidewalk to melt the carryover snow from adjacent property, for it is noticed that at times there is a small amount of such carryover snow and slush from the adjacent properties which do not have sidewalk coils. We would also investigate the possibilities of a forced fluid system using automatic control to maintain a definite slab temperature.

The present system was designed by Frank L. Wadsworth of the Office of S. Firestone, consulting engineers, and was installed by Bareham & McFarlin.

How to Design Snow Melting Coils

THE EDITOR—A few additional points should be noted in order to complete analysis of the snow melting coils discussed on page 101 of the September issue. Not always is the hourly snowfall the criterion for the design of the system. Extremely heavy falls are not only met just occasionally, but also will not last long. Now, on an airport runway, it would be important to melt the snow immediately in order to maintain operation under all conditions. Then again, on a sidewalk system, a coil or grid designed for maximum snowfall will prove to be not sufficiently economical. In such systems, it may be completely satisfactory to melt some of the snow after the snowfall has stopped.

Concerning the heat losses of snow melting panels, large variations may be noted. These losses depend mainly upon two factors —the geometrical shape of the snow melting area and the ground conditions. Since losses occur only along the circumference of the "panel", they may amount to less than 5 per cent in a large "square" area on dry ground and to more than 50 per cent in a long narrow strip of sidewalk located on highly conductive ground. Of course, these additional "losses" are used primarily to melt the snow adjoining the sidewalk and cannot strictly be considered as losses.

Even in narrow sidewalks, losses can be restricted to a minimum by proper design. A single tube, for instance, run in the center of the walk, could hardly result in considerable loss since most of the heat will actually melt the snow on the walk. Of course, the heat requirements are closely connected with the heat losses and, for this reason, are difficult to predict.

—R. G. V.

Why Different Headroom For Stokers in Boilers?

YOU ARE invited to submit an answer to the following question from "S. R. A." for publication in these pages. Suitable answers will be paid for at regular rates, with additional payment for sketches. You are invited, too, to submit a question about heating, piping, or air conditioning for publication here.

"S.R.A." Asks Information

Why do stoker manufacturers state that the headroom over underfeed stokers may be less in cast iron boilers than in steel boilers? Most stoker manuals say that the distance from the top of the retort to the crown sheet in cast iron boilers may be seven-eighths of that for steel boilers.—S. R. A.

What Kind of Heating for Housing Program?

NHA Analyzes the Types of Systems and Fuels for Single and Multifamily Units

RESULTS OF A study of fuels and heating systems planned by builders for use in new structures built under the Veterans Emergency Housing Program were recently released by the National Housing Agency.

An analysis was made of approved priority applications filed between January 15 and July 26, 1946, representing authorizations for more than 629,000 dwelling units. A "comprehensive sampling" was made of the applications to determine heating equipment requirements for the two year emergency housing program.

Approximately 93 per cent of the applications were for conventional, single family units. The remainder were conventional multifamily units. The figures in Table 1 show a breakdown of builders' choices of fuel for heating.

The types of heating systems selected by applicants are given in Table 2 ("overflow" heaters include floor furnaces, wall furnaces, and space heaters).

The proportions in which the various fuels will be used by each type of heating system are given in Table 3.

Division of steam and hot water systems between single and multifamily units is shown in Table 4.

The distribution of fuel preference by geographical regions and the total heating equipment requirements of the program for the last six months of 1946 and all of 1947 are shown in Tables 5 and 6. In addition to single and multifamily conventional units, the requirements chart reflects the needs of the entire program including conversions of existing structures into additional living accommodations; the program to re-use surplus war housing in temporary units; factory made houses; and trailers. It is assumed the type of equipment used in the last six months of 1946 and in 1947 will follow the pattern set in the first six months of this year.

Table 1

Fuel type	Per cent of all applications
Coal	27
Oil	21
Gas	52

Table 2

Heating System	Per cent of all applications	Per cent of all applications for single family units
Steam and hot water	17	15
Forced warm air	25	26
Gravity warm air	25	25
"Overflow" heaters	33	34

Table 3

Fuel	Boilers	Forced warm air furnaces	Gravity warm air furnaces	"Overflow" heaters
Coal	33%	20%	46%	17%
Oil	37	28	8	15
Gas	30	52	46	68

Table 4

Heating system	Multifamily	Single family	Total
Steam	35%	45%	44%
Hot water	65	55	56

Table 5—Geographical distribution of fuel choices

Fuel	Total U. S.	New England	Middle Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific
Coal	27%	30%	32%	51%	26%	30%	51%	1%	20%	5%
Oil	21	55	22	11	15	48	17	3	19	17
Gas	52	15	46	38	59	22	32	96	61	78

New England—Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut.
Middle Atlantic—New York, New Jersey, Pennsylvania.
East North Central—Ohio, Indiana, Illinois, Michigan, Wisconsin.
West North Central—Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas.
South Atlantic—Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida.
East South Central—Kentucky, Tennessee, Alabama, Mississippi.
West South Central—Arkansas, Louisiana, Oklahoma, Texas.
Mountain—Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada.
Pacific—Washington, Oregon, California.

Table 6—Heating system requirements

	Last 6 months 1946	Total 1947
Boilers		
Coal	25,000	52,000
Oil	28,000	57,000
Gas	22,000	46,000
Forced warm air furnaces		
Coal	26,000	64,000
Oil	36,000	89,000
Gas	68,000	167,000
Gravity warm air furnaces		
Coal	58,000	145,000
Oil	10,000	26,000
Gas	57,000	144,000
"Overflow" heaters		
Coal	32,000	80,000
Oil	147,000	174,000
Gas	316,000	716,000
Radiation (square feet)*	19,365,000	35,765,000
Oil storage tanks	170,000	280,000
Controls (separate items)	1,550,000	3,500,000

* Includes cast iron radiators, cast iron convectors, and extended surface convectors.

NEW BOOKS & REPORTS

7th Edition of Air Conditioning Manual Now Off the Press

The Trane Air Conditioning Manual, widely used as a reference volume by engineers and as a textbook by many colleges, is again off the press, this time the seventh printing. The book was first published in April 1938 and was revised in 1941. This is the latest of four printings of the revised edition.

The volume consists of 376 pages divided into eight chapters on heat, comfort, heat gains, properties of air and the psychrometric chart, calculations for the conditioned air supply, refrigeration for air conditioning, water for air conditioning, and ducts and fans. Many time-saving reference tables are included and one of the most valuable sections of the book is the portion devoted to the properties of air, clarified by illustrations and sample calculations. As in the past, psychrometric charts, cooling load estimate sheets, and a specially designed air conditioning ruler are included with the book.

This excellent text, 8 × 11 in. clothbound, is available from the Trane Co., La Crosse, Wis., for $5.00.

Writes Text on Fuels, Burners For Dealers, Salesmen, Mechanics

A handy and well illustrated text, Fuels and Fuel Burners, by Kalman Steiner covers the characteristics, properties, and the burning of coal, gas, and oil from the standpoint of the everyday needs of fuel and fuel burner dealers and salesmen and for installation and service mechanics. The author, fuel engineer, C. Hoffberger Co., and member of HPAC's board of consulting and contributing editors, points out in his preface that the subject of fuels and their utilization is so broad that any text must be limited in scope. Moreover, industrial fuels and burners have been extensively discussed in power plant texts and related works.

He believes that standard publications on heating tend to assume a knowledge of fuels on the part of the reader and devote but limited space to this subject. In this book, coal has received more attention than other fuels because it is used more extensively than others, because a great deal of published material is available on gas and gas burning equipment, and because the author has written two other texts covering design, construction, operation, and maintenance of oil burners for residential, commercial, and industrial use.

The three chapters on oil and oil burners are condensed from the author's other works and most of the chapters have been reviewed by specialists in particular fields of fuels and their applications.

The first chapters describe the formation and occurrence of natural and manufactured fuels. Oil and natural gas occurrence is also described and annual production figures for all fuels are included. In the chapter on elements of combustion, heating value, combustion efficiency charts, flue gas analysis, fuel-air ratios, and combustion rates and temperatures are briefly mentioned.

A chapter on coal composition and classification briefly covers such topics as proximate analysis, ultimate analysis, heating value, caking tendency, and classifications by rank and by grade. The following chapter describes various ways in which coal is prepared for residential and commercial use. These include washing, sizing, and dustless treatment.

The chapters on hand firing, stokers, and stoker installation and operation contain a good deal of information which will be of interest and value to the types of readers for whom this text was written. The results of many studies made by various colleges, laboratories, and associations are contained in the form of recommended practices. The various types of stokers, both for residential and commercial use, are described and illustrated. Oil burners and gas burning equipment are treated in much the same manner as stokers with illustrations and brief descriptions of each type being included.

Probably of considerable interest to the service man will be the chapter on fuel burner controls which will serve as a brief introduction to the various types and the many control systems which are commonly used. In addition to describing thermostats, limit controls, combustion controls, relays and starters, electronic controls such as flame failure safety devices are mentioned. The latter chapters describe chimneys and draft, control circuits, fans, and motors.

This 394 page, clothbound text, which also contains a chapter on wood fuel by R. H. P. Miller, engineer, Forest Products Laboratory, Madison, Wis., is published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 18, N. Y. Its price is $4.50.

Publishes Results of Studies on Underground Corrosion

Replacement of underground pipe lines made unserviceable because of corrosive action of soils costs $200 million a year in the United States alone, according to the National Bureau of Standards.

To help minimize this great economic loss the bureau has carried on a continuous investigation over a period of 25 years. The results of this investigation are presented in a new publication, Circular C450, prepared by H. H. Logan, head of the underground corrosion section.

Soil characteristics and conditions are so complex that it has been found impossible to correlate corrosion with any single soil property, the circular states. Likewise, no one pipe material or protective covering is the best under all soil conditions.

The bureau's studies indicate that ferrous materials in common use do not differ greatly in resistance to corrosion. However, ferrous alloys containing rather high percentages of nickel and chromium are definitely superior. Copper and alloys with a high copper content corrode much less and more uniformly than ferrous materials. On the other hand, lead is resistant to many soils but pits deeply in some of them.

Corrosion decreases with time and any corrosion rate data are applicable only to the area of the pipe that was actually tested and to the period in which measurements were made. For this reason the life of a pipe cannot be predicted from loss in weight or depth of a pit as measured during only one period.

The effectiveness of metallic coatings depends on the soils to which they are exposed, according to the circular. No one coating was found to be suitable for all soils. Bituminous coatings greatly retard loss of metal, their effectiveness being roughly proportional to their thickness. Unfortunately, very few of these coatings are free from pin holes and other imperfections.

"In this connection," the bureau states, "important causes of failure are improper application and injuries received while laying the pipe. Better tools and methods have reduced the failures from these causes, but it is still difficult to secure a completely protected pipe. Even after the pipe is in place the coating may be injured by soil stress and the roots of trees, shrubs, and grass."

The results of tests on a number of promising coatings developed in the laboratory are presented in the publication. Several procedures for testing soils and coatings also are described and corrosion prevention methods compared. Cathodic protection is shown to retard or prevent corrosion under most soil conditions. Methods for applying this electric type of protection are briefly described.

Copies of Circular C450 may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., at $1.25 each.

Refrigeration and Air Conditioning Equipment Standards Revised

The Air Conditioning & Refrigerating Machinery Association, Inc., has issued a new 1946 edition of its Equipment Standards which is a revision of those published in 1941 with the addition of a number of standards formulated in the interim.

These standards, which are not considered as inflexible or mandatory requirements but rather as helpful guides representing desirable industry practice, are not only widely used by the industry but by its customers. The new edition details 30 standards covering "Freon-12" and ammonia compressors and condensing units, room air conditioners, self-contained air conditioners, condensers and receivers, water and brine coolers, and six miscellaneous standards. The latter group covers ammonia mains, "Freon-12" mains, insulation for cold storage rooms, forced circulation air coolers, the location and inspection of data plates on insulated refrigerant-containing vessels, and steel and wrought iron pipe.

The booklet, containing over 100 pages, 26 illustrations, and 16 pages of tabular material, is priced at $2.00 and may be obtained from ACRMA headquarters, Southern Bldg., Washington 5, D. C.

Offers Data on Information Manuals for Employees

Considerable material that might assist chief executives and personnel managers in planning or revising a company employee manual is contained in the report, Information Manuals for Employees, recently prepared by the policyholders service bureau, Metropolitan Life Insurance Co.

A copy of this report is available to executives who request it on their business stationery. Address: Policyholders Service Bureau, Metropolitan Life Insurance Co., 1 Madison Ave., New York 10, N. Y.

MEETINGS & CONVENTIONS

AWS to Meet in Atlantic City

A total of 80 technical papers has been scheduled for presentation at the 24 sessions of the 1946 annual meeting of the American Welding Society to be held in Atlantic City, November 17-22. Society headquarters is at 33 W. 39th St., New York City.

ASME Annual Meeting and National Power Show to be Held in December

The American Society of Mechanical Engineers, 29 W. 39th St., New York, will hold its 1946 annual meeting, December 2 to 6 in that city. The 17th National Exposition of Power and Mechanical Engineering, better known as the National Power Show, will be held in Grand Central Palace, New York City, December 2-7.

ASHVE to Meet in Cleveland and to Attend Heating and Ventilating Show

In addition to sponsoring the 7th International Heating and Ventilating Exposition, to be held in Lakeside Hall, Cleveland, The American Society of Heating and Ventilating Engineers will hold its 53rd annual meeting in that city. Both the exposition and the meeting are scheduled for the last week in January. For more complete information and the tentative program see the ASHVE Journal Section in this issue.

The Society secretary is A. V. Hutchinson, 51 Madison Ave., New York 10.

Plans for ASTM National Meetings Now Under Way

The American Society for Testing Materials, 1916 Race St., Philadelphia 3, has announced that its spring meeting will be held February 24 to 28 at the Benjamin Franklin hotel, Philadelphia. Technical features of the 50th annual meeting, scheduled for June 16 to 20 at Chalfonte-Haddon Hall, Atlantic City, are being developed and will be announced at a later date.

Production for Profit to be Theme of Chicago Show and Conference

The Chicago Production Show, to be held March 17-19, 1947, in the exhibition hall of the Stevens hotel, will again be held in conjunction with the annual three-day conference of the 48 technical groups affiliated with the Chicago Technical Societies Council, sponsor of the show. Headquarters of the Societies Council is at 53 W. Jackson Blvd., Chicago 4.

Corrosion Engineers to Hold Annual Meeting in Chicago

April 7 to 10, 1947, are the dates selected by the National Association of Corrosion Engineers for its annual convention which will be held in the Palmer House, Chicago. Executive secretary of the association is Elton Sterrett, 905 Southern Standards Bldg., Houston 2, Tex.

British Engineers Make Novel Air Conditioning Installations

DETAILS OF A completely air conditioned factory five miles long, set up in one of London's standard 12 ft diameter underground tubes were given recently in the Journal of the Institution of Heating and Ventilating Engineers, Vol. 14, No. 135. Large quantities of precision parts were produced there during the war, the operations including hardening with consequent high rates of heat release.

Underground Factory

Most of the tunnel is at a depth of 50 to 80 ft below the surface; the floor area totalled 300,000 sq ft and the volume about 3,000,000 cu ft; the ventilation problem, allowing six air changes per hour, was therefore sizeable. The center-line ceiling height was 9 ft 3 in.

Entrances and exits were provided at three stations and two intermediate points; four canteens were installed, one of which could seat 650 persons and the other three 400 persons each. Cooking was done in the largest canteen and food was conveyed in insulated containers to the other three. Lavatory blocks 50 ft long were equipped with waterborne sanitation. Each was separately ventilated through the annular space between a 10 in. tube and a 4 in. sewage injection pipe in the tube. Lighting fixtures, suspended from the tunnel lining, provided a minimum of 25 foot candles at the working plane.

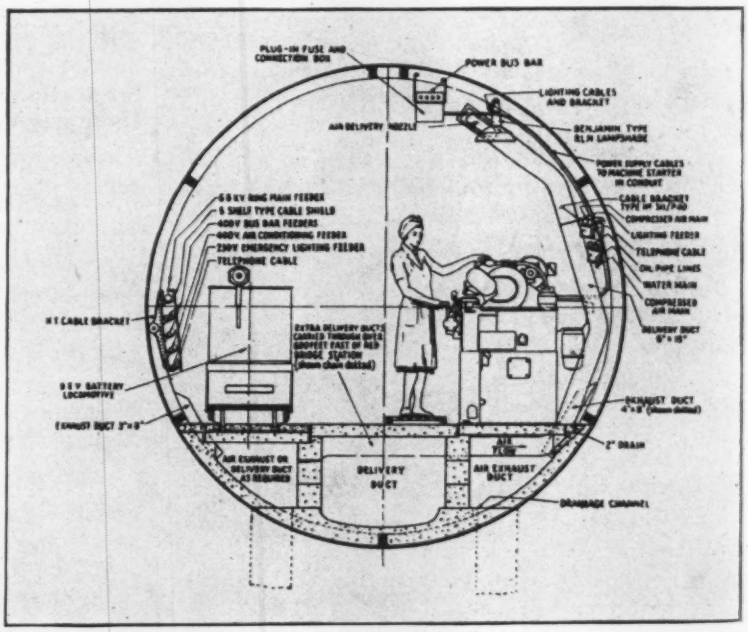
The "walls" of this factory were cast iron segments surrounded by London clay which had, of course, an enormous thermal capacity. Though refrigeration plants were provided from the start there was little need for them in the first year until more and more heat became stored in the clay. In the discussion on the paper, it was stated that the records of heat absorption into the clay showed that there was an initial storage period of about two years, and the enormous thermal capacity prevented any rapid temperature change in the tube itself. It was desired to maintain 65 F in the working spaces, with a continuous load factor for the 24 hours, about 2000 employees, a total lighting load of 350 kw, and about 2000 hp production machinery.

Actual conditions obtained were 65 to 67 F with relative humidity of 50 to 60 per cent. Production records showed a marked improvement in output from the same operatives in the tunnels compared with that in their previous surface factory. While this may have been due in part to an added sense of security, it seemed obvious that controlled environmental conditions had been an important factor in the increased output. Controlled comfort conditions were desired by production engineers to assist in insuring accuracy of the product. Some of the difficulties of accurate control will be appreciated when it is considered that conditioned air had to be conveyed for up to about ¼ mile in a straight line, picking up heat en route.

Air conditioning equipment was installed at three stations where 22 ft diameter tunnels were available and at one intermediate point where a portion of the tunnel was near the surface.

Few Complaints of Drafts

The equipment at each station consisted of a chill water spray chamber, eliminator plates, an 84 kw heater battery to heat the saturated air, and an 18,000 cfm centrifugal fan. Air was delivered by underground ducts to points every 60 ft along the tunnels. At each branch delivery duct 600 cfm of air was distributed by nozzles facing each way axially along the tunnel and fixed about 8 ft above the floor. The nozzle velocity was about 650 fpm and the throw about 30 ft. With supply air at a minimum



Section of tunnel showing air conditioning, piping, electrical and other services

temperature of 50 F and with air movement kept below 90 fpm, there were few complaints of drafts.

Recirculation was adopted at all times when the wet bulb temperature of the outdoor air was outside the range 50 to 56 F. By automatic damper control the amount of air recirculated could be varied between 25 and 75 per cent.

Refrigeration Plants

The compressors, condensers, and evaporators were housed in blast- and splinterproof buildings at the surface. Carbon dioxide was used as the refrigerant. A pair of lamps actuated by outside air conditions were used instead of elaborate control gear —difficult or impossible to obtain in wartime Britain—to indicate whether or not refrigeration was needed at any time. The installed refrigeration capacity totalled about 8.5 million Btu per hr to take care of a total electrical load of about 7 million Btu and an occupancy load of 1 million Btu. When the heat treatment shops were placed in the tunnel this section was cooled by the special delivery and extraction of outer air. This section was isolated from other sections of the tunnel.

Control Arrangements

To understand the control methods used it should be remembered that the average outdoor air dry bulb temperature around London in July is 64½ F (80 F and over is quite unusual) and in January about 41½ F. For this factory the "winter condition" occurred when the outdoor wet bulb was below 50 F. During this time the recirculation damper was opened to help maintain the required dew point condition and the reheater controlled by a modulation step controller. When the wet bulb was between 50 F and 56 F, 100 per cent outdoor air was used. During "summer conditions" (that is, over 56 F wet bulb) the recirculation damper was opened to economize refrigeration since the outside dry-bulb was then at a higher level than the controlled factory temperature.

Calculations made to discover whether refrigeration was required revealed that in July, using 100 per cent outside air at an overall temperature of 64.5 F, the total internal heat load of about 7 million Btu would have given an average day and night factory temperature of 80.7 F. Similar use of 100 per cent outside air in January, when the average dry bulb outside air temperature was 41.3 F, would have given an average day and night factory temperature of 66.4 F. In the first case (July) there would have been an hourly heat "soak-away" to the clay estimated at 1.7 million Btu per hr; in January there would have been a heat input from the clay estimated at 1.25 million Btu per hr. This will give some idea of the enormous thermal capacity of the surrounding clay in this installation.

The author of the paper, S. C. Mount, is in charge of the design of ventilation for tubes, works, and canteens of the London Transport.

HEAT PUMP PLANT PROTECTS WORKS OF ART

DURING THE war, many of Britain's valuable works of art and museum specimens were stored in subterranean workings where the initial ambient conditions varied between 46 F and 52 F with relative humidities between 90 and 100 per cent. Some of the engineering aspects of this storage problem were given in a paper presented before the Institution of Heating and Ventilating Engineers by Paul Fletcher. (Journal, IHVE, Vol. 11, No. 120).

One of the air conditioning plants there described delivered 12,000 cfm at 70 to 75 F dry bulb and 30 per cent relative humidity, the air returning to the plant at 60 to 65 F with 60 per cent relative humidity. In maintaining the storage space at 65 F and 58 per cent relative humidity, about 95 lb per hr of water was extracted.

The maximum heating load was 750,000 Btu and the average fuel consumption 200 lb of coke per 8 hr shift.

Vol. 14, No. 135, of the same journal contains an article by A. C. Pallot describing how this air conditioning system was converted to heat pump principles with consequent substantial savings in operating costs.

The air conditioning plant as originally installed and as modified is shown diagrammatically herewith. In the original plant the condensers were cooled by means of a separate fan with 20 bhp motor, the air being discharged up a separate shaft to atmosphere. Thus, the heat received from the air and developed by the compressors was lost. It was found that the air drawn from the unused part of the quarry in which the valuables were being stored remained saturated at a temperature of 53.5 F the year 'round. Since this air left the washer at 40 F saturated, the chilled spray water removed about 7 Btu per lb of air; this was absorbed in the baudelot cooler.

To effect the change new condensers were fixed in the main air stream to act as air reheaters. The cycle of operations is given as follows: Methyl chloride leaves the compressors as a gas at about 150 F; in the condenser coils it gives up heat to the air and is converted to a liquid at about 95 F. It flows to the liquid receiver and thence to the coils of the baudelot cooler where it evaporates to a gas, absorbing latent heat from the water pumped over the coils. It reenters the compressor at about 30 F and the chilled water, returned from the air washer tank at about 40 F, leaves the baudelot cooler at 36 F and is sprayed again into the washer.

The heat removed from the air, in the baudelot cooler, together with the heat added by compression in the refrigerators, is available in the con-

Cyril Tasker, director of research of the American Society of Heating and Ventilating Engineers, has functioned for some time as a sort of one-way trans-Atlantic cable, for he has contributed regular articles to a British magazine on American research and practice in heating and air conditioning. In these abstracts, he "reverses the field" and summarizes three recent British papers believed to be of interest to American readers.

denser to raise the temperature of the air stream.

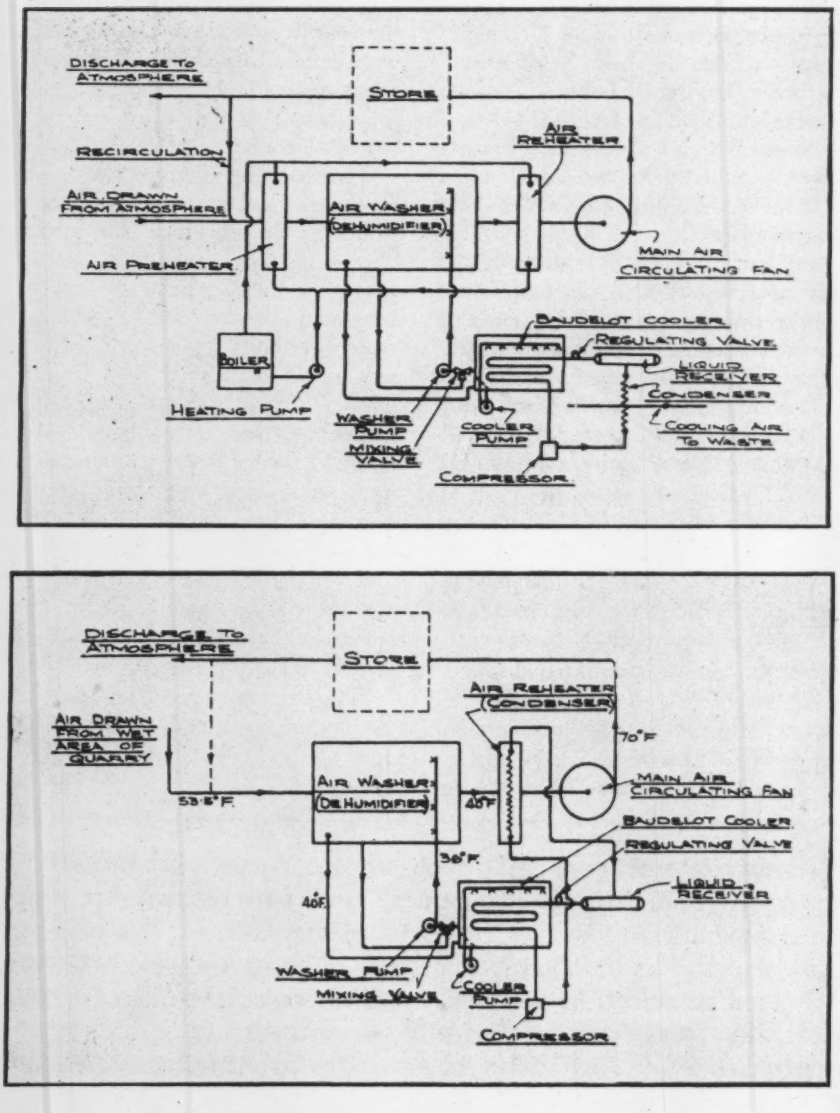
As installed, thermal balance was obtained with 7500 cfm of air entering the washer. The heat transferred to the refrigerant totaled approximately 309,000 Btu per hr; about 269,000 Btu per hr was required in the condenser to heat the air from 40 F to 70 F. The report shows that this amount of heat was obtained with a power consumption of 20 kw (67,000 Btu per hr); the "coefficient of performance" is therefore about four.

First Application of Heat Pump

The conversion, made in the autumn of 1943, is believed to be the first practical application of heat pump principles made in the United Kingdom. Thereafter the coke fired boilers were not required and the original condenser fan, together with some hot water pumps and small auxiliaries, were shut down. For equivalent six month periods in 1943 and 1944 the comparative costs, converted on a basis of one pound sterling equalling four dollars, are given as:

Before conversion	
Electrical energy	$5360
Coke	1400
Total	$6760
After conversion	
Electrical energy (66.4% of that previously used)	$3360
Savings	$3320

Air conditioning plant as originally installed (above) and as modified to employ the heat pump principle (below)



EFFECT OF PANELLING ON INTERMITTENT HEATING

FOR ANY system of "background" heating to 50 F or 55 F, with "topping up" to 65 F for comfort when needed, as recommended in the British report reviewed in the September HPAC, methods whereby the time needed to attain comfort after the additional heat has been supplied can be reduced are of considerable interest. A report in the Journal of the Institution of Heating and Ventilating Engineers, Vol. 14, No. 135, from the heating laboratory of the Building Research Station deals with the effect of panelling of the walls on the intermittent heating of rooms.

An investigation was made of the rate of warming of a room using a gas fire, two loadings of electric tubular heaters, a convection heater, and a reflector type of radiant fire, the tests being repeated after the walls of the room had been lined with a ½ in. fibrous wallboard mounted on ½ in. battens. The room was 18 ft by 12 ft and 11 ft 6 in. high, with a fireplace at one end. The walls were of 9 in. brickwork and there were two windows in one of the larger walls. The lath and plaster ceiling was boarded above and the floor had a lath and plaster ceiling below it.

During the tests the walls, ceiling, and floor were exposed externally to surfaces at 50 F except the wall containing the windows, which faced a surface controlled at 25 F.

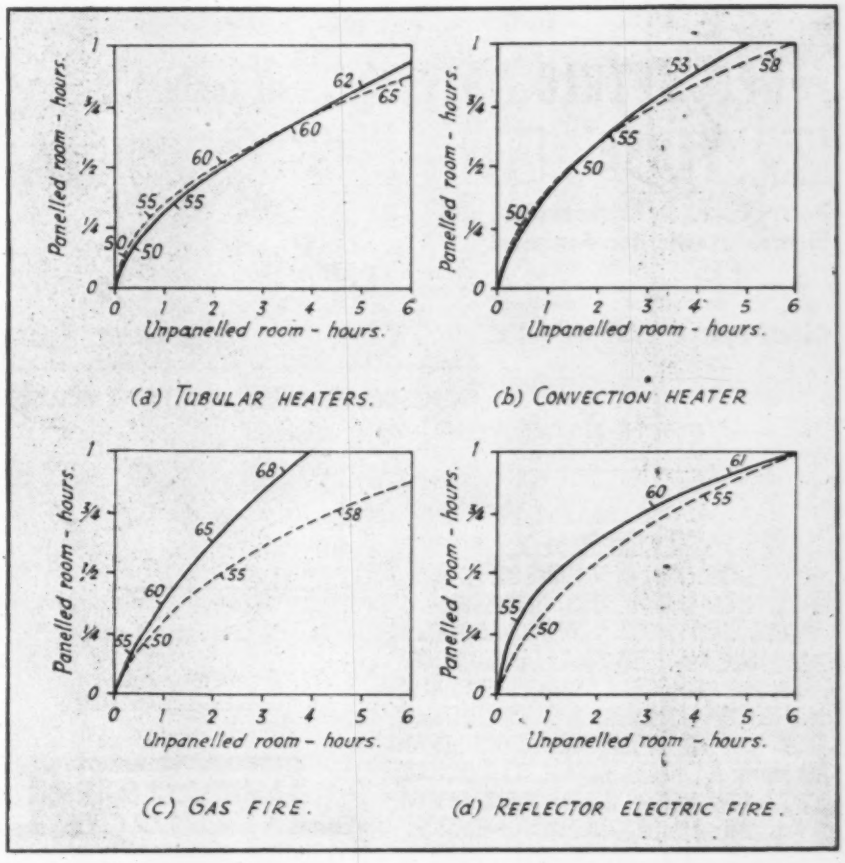
Records were taken of the equivalent temperature at the center of the room (by means of a eupatheoscope) and the mean air temperature at two points above the center of the room 33 in. above floor level. The air temperature in the unheated room, in its controlled environment, was about 45 F.

Rise in Air Temperature

Table 1 shows the rise in air temperature in an unventilated room after one hour's warming before and after panelling, while the times required to warm the panelled room against the times required to warm the unpanelled room are shown in the curves.

The report points out that "though it is in intermittent heating that the economies effected by the use of panelling are most significant, the added insulation is ad-

Times required to warm panelled room against times required to warm unpanelled room (the solid curves are marked in degrees of equivalent temperature, the dotted curves in air temperature)



vantageous when continuous heating is required." Tests made with the panelled room, to repeat tests made previously in the unpanelled room, showed that 26 per cent less heat was required in the panelled room to maintain an equivalent temperature of 65 F. Another test was made in which the panelling on the wall containing the windows was modified by increasing the space between the wallboard and the wall to 1 in. and subdividing it by asbestos paper surfaced on each side with aluminum. The 26 per cent saving obtained in the previous experiment was increased to 41 per cent by this added insulation.

The report concluded by pointing out that "with panelling it is possible to warm a room reasonably quickly with a relatively small input of heat." These tests are perhaps worth some attention on the part of those interested in problems of intermittent heating to see whether panelling might cut both first costs and operating costs and give greater comfort to the occupants.

Table 1—Rise in air temperature in unventilated room after one hour's warming

	Unpanelled room			Panelled room		
	Load in kw	Temperature rise F	Temperature rise per kw load	Load in kw	Temperature rise F	Temperature rise per kw load
Tubular heaters	4.49	12.3	2.74	4.35	21.1	4.85
Tubular heaters	2.98	9.1	3.05	2.99	15.3	5.12
Convection heater	2.90	8.5	2.93	2.93	13.9	4.74
Reflector electric fire	2.28	7.1	3.11	2.25	11.3	5.02

OTS ISSUES REPORT ON DRYING

Comprehensive technical information on liquid and solid gas drying agents, including the properties and methods of using each drying agent, is contained in a 152 page report on sale by the Office of Technical Services, Department of Commerce. The material is potentially useful for the air conditioning, food, automotive, textile, chemical, and other industries where humidity problems are significant.

Prepared in 1941 by O. A. Hougen and F. W. Dodge for the Office of Scientific Research and Development, the report was intended as a general reference work to assist in the solution of gas drying problems in national defense projects. It was held confidential until 1946.

Solid or liquid drying agents are used for many different purposes: air conditioning; in storage compartments on ships and in tropical homes; in protecting electrical equipment; in the air used in chemical, combustion, and metallurgical processes; for final drying in the liquefaction of gases; for drying sealed compartments in some optical instruments; in electrostatic equipment; and for the protection of engines and other machinery in storage or shipment.

Seven methods are in general use for drying gases, according to the report. They involve:

1) Cooling air below its dew point by the use of surface condensers.

2) Cooling below the dew point by the use of cold water sprays.

3) Compressing gases to a point where the partial pressure of the water vapor exceeds its saturation pressure.

4) Combining compression and cooling.

5) Absorption in spray chambers, using organic liquids, such as glycerin, or aqueous solutions of salts, such as lithium chloride.

6) Absorption in packed columns, using a countercurrent flow of sulfuric acid, phosphoric acid, or organic liquids.

7) Absorption of water vapor in solid desiccants.

Orders for the report (The Drying of Gases; PB-23201; photostat, $11; microfilm, $2) should be addressed to the Office of Technical Services, Department of Commerce, Washington, D. C., and should be accompanied by check or money order payable to the Treasurer of the United States.

GEO-METRIC VERSE

Poetry Forms in Mathematics
Written mostly for Fanatics

by

Gerald Lynton Kaufman, A.I.A.

SIGH-ANGLES

TWO TRIANGLES SIGHED FOR HOWEVER THEY TRIED
THEY COULD NOT COINCIDE
FOR ONE WAS A CUTE ONE, RETIRING, RECLUSE
THE OTHER, DIFFUSE AND PROFUSELY OBTUSE

INFINITEM

INFINITY SEEMS ODD TO ME · WHAT CANNOT HAPPEN ANYWHERE, SO OFTEN HAPPENS HERE · THE REASON MAY BE QUEER

A DOGGEREL-O-PIP-E-DON

IF THIS POEM SEEMS ERRATIC DO NOT HARBOR A SUSPICION
AND ITS METRE IS ATROCIOUS THAT THE FAULT IS ACCIDENTAL
OR THE PHRASES UNGRAMMATIC NOR CONDEMN ITS POETICISM
MAKE A DOG-GER-EL FEROCIOUS AS A PAR-AL-LEL-E-MEDON
BUT CONSIDER HIM A BIPED
LIKING EQUALLY THE SONNET
AND THE PAR-AL-LEL-O-PIPED
WITH A DOG-GER-EL UPON IT
OR SENTIMENTS INSPIRED ON
A PAR-AL-LEL-O-PIP-EDON

CIRCLE-ELEGEE

THE CURFEW TOLLS
THE KNELL OF PARTING DAY
THE CIRCLE REPRESENTS A SETTING SUN
THAT STARTS AN ELEGY FOR THOMAS GRAY
BUT, FOR SOME OTHERS, STARTS A ROUND OF FUN.
TURN NOW FROM GRAY, TO ARCHIMEDES' NAME
AND IF FOR MATHEMATICS YOU SHOULD CARE
THINK HOW THE LATTER CARRIED OUT HIS AIM
TO MAKE A CIRCLE EQUAL TO A SQUARE
COULD SOMEONE FOR THESE TWO AT ONCE ENGRAVE
A MEDAL, ITS DESIGN SHOULD NEVER BE
OF PATHS OF GLORY LEADING TO A GRAVE
BUT LEADING RATHER, WITH A FANCY
FREE, AROUND AND ROUND A
CIRCLE-ELEGEE

RHYTHMICROSS

A MATTER OF COURSE
IN A REGULAR CROSS
IS TO HAVE THE DIMENSIONS AGREE
BY SETTING THE LIMITS JUST RIGHT
SO THE WIDTH IS THE SAME AS THE HEIGHT
BUT IN WRITING THIS POEM, YOU SEE
HOW THE AUTHOR WAS QUITE AT A LOSS
FOR HIS VERSES COULD NEVER BE FREE
AND HIS EFFORT TO PUT THEM ACROSS
MADE THE OUTCOME AS
CROSS AS COULD BE

ANGOLET

IN
STEAD
OF WRITING
STUPID JANGLES
AND LAPSING INTO
FOSSIL EASE ~ I MUCH
PREFER TO WRITE TRIANGLES.
ESPECIALLY THE I-SOS-CE-LES.

CUBICOUPLETS

A CUBE HAS SIX FACES A CUBE HAS SIX PLANES
RECTANGULAR SPACES FOR METRIC REFRAINS
FOR COUPLETS LIKE THESE WITH A RHYTHM, OF COURSE
TO BE READ AS YOU PLEASE EITHER DOWN OR ACROSS
EVERY FACE IS A SQUARE EVERY EDGE IS A LINE
TO HELP YOU COMPARE TO UNITE AND COMBINE
TWO PLANES AT A TIME FROM BEHIND OR BETWEEN
IN THIS CUBICAL RHYME WITH THE VERSES UNSEEN

A CUBE HAS SIX PLANES A CUBE HAS SIX FACES
FOR METRIC REFRAINS RECTANGULAR SPACES
WITH A RHYTHM, OF COURSE FOR COUPLETS LIKE THESE
EITHER DOWN OR ACROSS TO BE READ AS YOU PLEASE
EVERY EDGE IS A LINE EVERY FACE IS A SQUARE
TO UNITE AND COMBINE TO HELP YOU COMPARE
FROM BEHIND OR BETWEEN TWO PLANES AT A TIME
WITH THE VERSES UNSEEN IN THIS CUBICAL RHYME

DACTYLLIC FRUSTUM

IT'S TERRIBLY SAD WHEN A CONE
IS FRUSTRATED AND STANDS ALL ALONE
WITH ITS APEX TRUNCATED... WHENEVER
I FIND ONE WHOSE SLOPE SEEMS INVITING
I COVER ITS SURFACE WITH METRICAL WRITING
IN CHEERFUL TETRAMETER, SOMEWHAT IDYLLIC
CAST IN A MOULD THAT IS SLIGHTLY DACTYLLIC
WHENEVER AN APEX HAS PROVEN SO FRACTILE
THE FRUSTUM HAS DEFINITE NEED OF A DACTYL
TO LIGHTEN ITS SPIRIT AND SERVE AS A TONIC
FOR MALADIES EQUALLY CHRONIC AND CONIC
EXCUSE ME, DEAR CONE, IF MY METRE IS HECTIC
SOME OF THE SYLLABLES WENT CATALECTIC

LIGHT VERSE

THE
LORD
SAID: LET
THERE BE LIGHT
AND TOM EDISON
THOUGHT THIS WAS RIGHT
NOW WE ALL WORK OR PLAY
HALF AS LONG EV'RY DAY
AND TWICE AS LONG
EVERY NIGHT

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DATA SHEET

ENGINEERING DATA on REFRIGERANTS Given in New TABLES

In deciding which refrigerant to use under a specific set of conditions, tables are needed which give engineering data such as weight and volume of refrigerant to be circulated per ton, and horsepower and capacity. Such tables, in addition to the basic data on thermodynamic properties, are of value in showing at a glance just which refrigerant would be desirable under a given set of circumstances.

For this reason various sets of tables* have been prepared for "Freon"-11, -12, -21, -22, and -113, ammonia, methyl chloride, and water vapor. These tables enable the user to make rapid comparisons of the important basic data needed in deciding whether a refrigerant is suitable for a given set of circumstances. Temperatures are shown in degrees Fahrenheit.

The tables are easy to use. The temperature of the liquid ahead of the expansion valve is equal to the condensing temperature if no subcooling takes place. However, a small amount of subcooling usually takes place in most condensers. It is reasonably safe to figure that the temperature of the liquid ahead of the expansion valve will be about 5 F lower than the actual condensing temperature. The actual condensing temperature corresponding to any given head pressure can, of course, be found in the tables for saturated liquid.

*See HPAC, June 1944, pp. 337-338, July 1944, p. 409, August 1944, pp. 478-480, October 1944; pp. 593-594, May 1945, pp. 256-258, December 1945, pp. 616-618, March 1946, pp. 91-93, May 1946, pp. 83-85, and August 1946, pp. 91-93.

"Freon-11"—Theoretical capacity of refrigerating compressors
(Saturated vapor leaving evaporator)
Tons per cu ft per min of vapor compressed

Evap Temp	Temperature of liquid ahead of expansion valve													
	60	65	70	75	80	85	90	95	100	105	110	115	120	125
-20	0.0145	0.0143	0.0141	0.0139	0.0137	0.0134	0.0132	0.0130	0.0128	0.0126	0.0124	0.0121	0.0119	0.0117
-18	.0154	.0152	.0150	.0148	.0145	.0143	.0141	.0138	.0136	.0134	.0131	.0128	.0127	.0124
-16	.0164	.0162	.0159	.0157	.0154	.0152	.0149	.0147	.0145	.0142	.0140	.0136	.0135	.0132
-14	.0174	.0171	.0169	.0166	.0164	.0161	.0159	.0156	.0154	.0151	.0148	.0145	.0143	.0140
-12	.0185	.0182	.0179	.0176	.0174	.0171	.0168	.0166	.0163	.0160	.0157	.0153	.0152	.0149
-10	0.0196	0.0193	0.0190	0.0187	0.0184	0.0181	0.0179	0.0176	0.0173	0.0170	0.0167	0.0163	0.0161	0.0158
- 8	.0207	.0204	.0201	.0198	.0195	.0192	.0189	.0186	.0183	.0180	.0177	.0173	.0171	.0168
- 6	.0219	.0216	.0213	.0210	.0207	.0203	.0200	.0197	.0194	.0191	.0187	.0183	.0181	.0178
- 4	.0232	.0229	.0225	.0222	.0219	.0215	.0212	.0209	.0205	.0202	.0198	.0194	.0192	.0188
- 2	.0245	.0242	.0238	.0235	.0231	.0228	.0224	.0221	.0217	.0214	.0210	.0205	.0203	.0199
0	0.0259	0.0256	0.0252	0.0248	0.0245	0.0241	0.0237	0.0233	0.0230	0.0226	0.0222	0.0217	0.0214	0.0210
2	.0274	.0270	.0266	.0262	.0258	.0254	.0250	.0247	.0243	.0239	.0235	.0229	.0227	.0222
4	.0289	.0285	.0281	.0277	.0273	.0269	.0265	.0260	.0256	.0252	.0248	.0242	.0239	.0235
6	.0305	.0301	.0297	.0292	.0288	.0284	.0279	.0275	.0271	.0266	.0262	.0256	.0253	.0248
8	.0322	.0317	.0313	.0308	.0304	.0299	.0295	.0290	.0285	.0281	.0276	.0270	.0267	.0262
10	0.0339	0.0335	0.0330	0.0325	0.0320	0.0315	0.0311	0.0306	0.0301	0.0296	0.0291	0.0284	0.0281	0.0276
12	.0358	.0353	.0348	.0343	.0338	.0333	.0328	.0322	.0317	.0312	.0307	.0300	.0297	.0292
14	.0377	.0371	.0366	.0361	.0356	.0350	.0345	.0340	.0334	.0329	.0324	.0316	.0313	.0307
16	.0397	.0391	.0386	.0380	.0375	.0369	.0363	.0358	.0352	.0347	.0341	.0333	.0329	.0324
18	.0417	.0412	.0406	.0400	.0394	.0388	.0382	.0377	.0371	.0365	.0359	.0351	.0347	.0341
20	0.0439	0.0433	0.0427	0.0420	0.0414	0.0408	0.0402	0.0396	0.0390	0.0384	0.0377	0.0369	0.0365	0.0359
22	.0461	.0455	.0448	.0442	.0436	.0429	.0423	.0417	.0410	.0404	.0397	.0388	.0384	.0377
24	.0485	.0478	.0471	.0465	.0458	.0451	.0444	.0438	.0431	.0424	.0417	.0408	.0404	.0397
26	.0509	.0502	.0495	.0488	.0481	.0474	.0467	.0460	.0453	.0446	.0438	.0428	.0424	.0417
28	.0534	.0527	.0519	.0512	.0505	.0498	.0490	.0483	.0476	.0468	.0460	.0450	.0445	.0438
30	0.0561	0.0553	0.0545	0.0538	0.0530	0.0522	0.0515	0.0507	0.0499	0.0491	0.0483	0.0472	0.0468	0.0460
32	.0588	.0580	.0572	.0564	.0556	.0548	.0540	.0532	.0524	.0515	.0507	.0496	.0491	.0483
34	.0616	.0608	.0600	.0591	.0583	.0575	.0566	.0558	.0549	.0541	.0532	.0520	.0515	.0506
36	.0646	.0637	.0629	.0620	.0611	.0602	.0593	.0585	.0576	.0567	.0558	.0546	.0540	.0531
38	.0677	.0668	.0659	.0650	.0641	.0631	.0622	.0613	.0604	.0595	.0585	.0572	.0566	.0557
40	0.0708	0.0699	0.0689	0.0680	0.0670	0.0660	0.0651	0.0641	0.0632	0.0622	0.0612	0.0599	0.0593	0.0583
42	.0741	.0732	.0722	.0712	.0702	.0692	.0682	.0672	.0662	.0651	.0641	.0627	.0621	.0610
44	.0775	.0765	.0755	.0745	.0734	.0724	.0713	.0703	.0693	.0682	.0671	.0657	.0650	.0639
46	.0811	.0801	.0789	.0779	.0768	.0757	.0746	.0735	.0724	.0713	.0702	.0687	.0680	.0669
48	.0848	.0837	.0825	.0814	.0803	.0792	.0780	.0769	.0758	.0746	.0735	.0718	.0711	.0700
50	0.0887	0.0875	0.0863	0.0851	0.0840	0.0828	0.0816	0.0804	0.0792	0.0780	0.0768	0.0751	0.0744	0.0732
52	.0926	.0914	.0902	.0889	.0877	.0865	.0853	.0840	.0828	.0816	.0803	.0786	.0778	.0765
54	.0967	.0954	.0942	.0929	.0916	.0903	.0890	.0878	.0865	.0852	.0839	.0820	.0812	.0799
56	.101	.0995	.0982	.0969	.0956	.0943	.0929	.0916	.0903	.0889	.0876	.0856	.0848	.0835
58	.105	.104	.102	.101	.0997	.0983	.0970	.0956	.0942	.0928	.0914	.0894	.0886	.0871

"Freon-11"—Volume of refrigerant to be compressed

(Saturated vapor leaving evaporator)

Cu ft per min per ton of refrigerating capacity

Evap Temp	Temperature of liquid ahead of expansion valve													
	60	65	70	75	80	85	90	95	100	105	110	115	120	125
-20	68.8	69.9	70.9	72.0	73.1	74.4	75.6	76.8	78.1	79.5	80.9	83.0	83.9	85.5
-18	64.8	65.8	66.7	67.8	68.8	69.9	71.1	72.2	73.5	74.8	76.1	78.0	78.9	80.4
-16	61.0	61.9	62.8	63.8	64.8	65.8	66.9	68.0	69.2	70.4	71.6	73.4	74.3	75.7
-14	57.5	58.3	59.2	60.1	61.1	62.0	63.0	64.1	65.1	66.3	67.5	69.2	69.9	71.2
-12	54.2	55.0	55.8	56.7	57.5	58.5	59.4	60.4	61.4	62.4	63.6	65.2	65.9	67.1
-10	51.1	51.9	52.6	53.4	54.3	55.1	56.0	56.9	57.9	58.8	59.9	61.4	62.1	63.2
- 8	48.2	49.0	49.7	50.4	51.2	52.0	52.8	53.7	54.6	55.5	56.5	57.9	58.6	59.6
- 6	45.6	46.2	46.9	47.6	48.4	49.2	49.9	50.7	51.6	52.4	53.4	54.7	55.3	56.3
- 4	43.1	43.7	44.4	45.0	45.7	46.4	47.2	47.9	48.7	49.5	50.4	51.6	52.2	53.2
- 2	40.7	41.3	41.9	42.6	43.2	43.9	44.6	45.3	46.0	46.8	47.6	48.8	49.3	50.2
0	38.6	39.1	39.7	40.3	40.9	41.5	42.2	42.9	43.6	44.3	45.1	46.2	46.7	47.5
2	36.5	37.0	37.6	38.1	38.7	39.3	39.9	40.6	41.2	41.9	42.6	43.7	44.1	45.0
4	34.6	35.1	35.6	36.1	36.6	37.2	37.8	38.4	39.0	39.7	40.4	41.3	41.8	42.5
6	32.8	33.2	33.7	34.2	34.7	35.2	35.8	36.4	37.0	37.6	38.2	39.1	39.6	40.3
8	31.1	31.5	32.0	32.4	32.9	33.4	33.9	34.5	35.0	35.6	36.2	37.1	37.5	38.2
10	29.5	29.9	30.3	30.8	31.2	31.7	32.2	32.7	33.2	33.8	34.3	35.2	35.5	36.2
12	28.0	28.4	28.8	29.2	29.6	30.1	30.5	31.0	31.5	32.0	32.6	33.3	33.7	34.3
14	26.5	26.9	27.3	27.7	28.1	28.6	29.0	29.4	29.9	30.4	30.9	31.6	32.0	32.5
16	25.2	25.6	25.9	26.3	26.7	27.1	27.5	28.0	28.4	28.8	29.3	30.0	30.4	30.9
18	24.0	24.3	24.6	25.0	25.4	25.8	26.2	26.6	27.0	27.4	27.9	28.5	28.8	29.3
20	22.8	23.1	23.4	23.8	24.1	24.5	24.9	25.2	25.6	26.1	26.5	27.1	27.4	27.9
22	21.7	22.0	22.3	22.6	23.0	23.3	23.6	24.0	24.4	24.8	25.2	25.8	26.0	26.5
24	20.6	20.9	21.2	21.5	21.8	22.2	22.5	22.8	23.2	23.6	24.0	24.5	24.8	25.2
26	19.6	19.9	20.2	20.5	20.8	21.1	21.4	21.8	22.1	22.4	22.8	23.3	23.6	24.0
28	18.7	19.0	19.2	19.5	19.8	20.1	20.4	20.7	21.0	21.4	21.7	22.2	22.4	22.8
30	17.8	18.1	18.3	18.6	18.9	19.2	19.4	19.7	20.0	20.4	20.7	21.2	21.4	21.8
32	17.0	17.2	17.5	17.7	18.0	18.3	18.5	18.8	19.1	19.4	19.7	20.2	20.4	20.7
34	16.2	16.4	16.7	16.9	17.2	17.4	17.7	17.9	18.2	18.5	18.8	19.2	19.4	19.8
36	15.5	15.7	15.9	16.1	16.4	16.6	16.8	17.1	17.4	17.6	17.9	18.3	18.5	18.8
38	14.8	15.0	15.2	15.4	15.6	15.8	16.1	16.3	16.6	16.8	17.1	17.5	17.7	18.0
40	14.1	14.3	14.5	14.7	14.9	15.1	15.4	15.6	15.8	16.1	16.3	16.7	16.9	17.2
42	13.5	13.7	13.9	14.0	14.2	14.4	14.7	14.9	15.1	15.4	15.6	15.9	16.1	16.4
44	12.9	13.1	13.2	13.4	13.6	13.8	14.0	14.2	14.4	14.7	14.9	15.2	15.4	15.6
46	12.3	12.5	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.2	14.6	14.7	15.0
48	11.8	12.0	12.1	12.3	12.4	12.6	12.8	13.0	13.2	13.4	13.6	13.9	14.1	14.3
50	11.3	11.4	11.6	11.8	11.9	12.1	12.3	12.4	12.6	12.8	13.0	13.3	13.4	13.7
52	10.8	10.9	11.1	11.2	11.4	11.6	11.7	11.9	12.1	12.3	12.4	12.7	12.9	13.1
54	10.3	10.5	10.6	10.8	10.9	11.1	11.2	11.4	11.6	11.7	11.9	12.2	12.3	12.5
56	9.92	10.0	10.2	10.3	10.5	10.6	10.8	10.9	11.1	11.2	11.4	11.7	11.8	12.0
58	9.50	9.63	9.76	9.89	10.0	10.2	10.3	10.5	10.6	10.8	10.9	11.2	11.3	11.5

"Freon-11"—Weight of refrigerant to be circulated

(Saturated vapor leaving evaporator)

Lb per min per ton of refrigerating capacity

Evap Temp	Temperature of liquid ahead of expansion valve													
	60	65	70	75	80	85	90	95	100	105	110	115	120	125
-20	2.86	2.90	2.95	2.99	3.04	3.09	3.14	3.19	3.25	3.30	3.36	3.45	3.49	3.55
-18	2.85	2.89	2.94	2.98	3.03	3.08	3.13	3.18	3.23	3.29	3.35	3.44	3.47	3.54
-16	2.84	2.88	2.93	2.97	3.02	3.07	3.12	3.17	3.22	3.28	3.34	3.42	3.46	3.52
-14	2.83	2.87	2.92	2.96	3.01	3.06	3.10	3.16	3.21	3.26	3.32	3.41	3.44	3.51
-12	2.82	2.86	2.91	2.95	3.00	3.04	3.09	3.14	3.20	3.25	3.31	3.39	3.43	3.50
-10	2.81	2.85	2.90	2.94	2.99	3.03	3.08	3.13	3.18	3.24	3.30	3.38	3.42	3.48
- 8	2.80	2.84	2.89	2.93	2.98	3.02	3.07	3.12	3.17	3.23	3.28	3.36	3.40	3.47
- 6	2.79	2.83	2.88	2.92	2.96	3.01	3.06	3.11	3.16	3.21	3.27	3.35	3.39	3.45
- 4	2.78	2.82	2.87	2.91	2.95	3.00	3.05	3.10	3.15	3.20	3.26	3.34	3.38	3.44
- 2	2.78	2.82	2.86	2.90	2.94	2.99	3.04	3.09	3.14	3.19	3.24	3.32	3.36	3.42
0	2.77	2.81	2.85	2.89	2.93	2.98	3.03	3.08	3.12	3.18	3.23	3.31	3.35	3.41
2	2.76	2.80	2.84	2.88	2.92	2.97	3.02	3.06	3.11	3.17	3.22	3.30	3.33	3.40
4	2.75	2.79	2.83	2.87	2.91	2.96	3.00	3.05	3.10	3.15	3.21	3.29	3.32	3.38
6	2.74	2.78	2.82	2.86	2.90	2.95	2.99	3.04	3.09	3.14	3.20	3.27	3.31	3.37
8	2.73	2.77	2.81	2.85	2.89	2.94	2.98	3.03	3.08	3.13	3.18	3.26	3.29	3.35
10	2.72	2.76	2.80	2.84	2.88	2.93	2.97	3.02	3.07	3.12	3.17	3.25	3.28	3.34
12	2.71	2.75	2.79	2.83	2.87	2.92	2.96	3.01	3.06	3.11	3.16	3.23	3.27	3.33
14	2.70	2.74	2.78	2.82	2.86	2.91	2.95	3.00	3.04	3.09	3.15	3.22	3.26	3.31
16	2.69	2.73	2.77	2.81	2.85	2.90	2.94	2.99	3.03	3.08	3.13	3.21	3.24	3.30
18	2.68	2.72	2.76	2.80	2.84	2.89	2.93	2.98	3.02	3.07	3.12	3.20	3.23	3.29
20	2.68	2.71	2.75	2.79	2.83	2.88	2.92	2.96	3.01	3.06	3.11	3.18	3.22	3.27
22	2.67	2.70	2.74	2.78	2.82	2.86	2.91	2.95	3.00	3.05	3.10	3.17	3.20	3.26
24	2.66	2.70	2.73	2.77	2.81	2.86	2.90	2.94	2.99	3.04	3.09	3.16	3.19	3.25
26	2.65	2.69	2.72	2.76	2.80	2.85	2.89	2.93	2.98	3.03	3.08	3.15	3.18	3.24
28	2.64	2.68	2.72	2.75	2.79	2.84	2.88	2.92	2.97	3.02	3.06	3.14	3.17	3.22
30	2.63	2.67	2.71	2.74	2.78	2.83	2.87	2.91	2.96	3.00	3.05	3.12	3.16	3.21
32	2.62	2.66	2.70	2.74	2.78	2.82	2.86	2.90	2.95	2.99	3.04	3.11	3.14	3.20
34	2.62	2.65	2.69	2.73	2.77	2.81	2.85	2.89	2.94	2.98	3.03	3.10	3.13	3.18
36	2.61	2.64	2.68	2.72	2.76	2.80	2.84	2.88	2.93	2.97	3.02	3.09	3.12	3.17
38	2.60	2.64	2.67	2.71	2.75	2.79	2.83	2.87	2.92	2.96	3.01	3.08	3.11	3.16
40	2.59	2.63	2.66	2.70	2.74	2.78	2.82	2.86	2.90	2.95	3.00	3.07	3.10	3.15
42	2.58	2.62	2.66	2.69	2.73	2.77	2.81	2.85	2.90	2.94	2.99	3.05	3.08	3.14
44	2.58	2.61	2.65	2.68	2.72	2.76	2.80	2.84	2.88	2.93	2.98	3.04	3.07	3.12
46	2.57	2.60	2.64	2.67	2.71	2.75	2.79	2.83	2.88	2.92	2.97	3.03	3.06	3.11
48	2.56	2.59	2.63	2.67	2.70	2.74	2.78	2.82	2.86	2.91	2.96	3.02	3.05	3.10
50	2.55	2.59	2.62	2.66	2.69	2.73	2.77	2.81	2.86	2.90	2.94	3.01	3.04	3.09
52	2.54	2.58	2.61	2.65	2.69	2.72	2.76	2.80	2.84	2.89	2.93	3.00	3.03	3.08
54	2.54	2.57	2.60	2.64	2.68	2.72	2.75	2.79	2.84	2.88	2.92	2.99	3.02	3.07
56	2.53	2.56	2.60	2.63	2.67	2.71	2.74	2.78	2.83	2.87	2.91	2.98	3.01	3.06
58	2.52	2.55	2.59	2.62	2.66	2.70	2.74	2.78	2.82	2.86	2.90	2.97	3.00	3.04

"Freon-11"—Theoretical horsepower per cu ft per min of vapor compressed

Evap Temp	Condensing temperature													
	60	65	70	75	80	85	90	95	100	105	110	115	120	125
-20	0.0141	0.0150	0.0157	0.0165	0.0173	0.0180	0.0188	0.0196	0.0203	0.0210	0.0218	0.0224	0.0231	0.0238
-18	.0145	.0154	.0162	.0171	.0179	.0187	.0195	.0203	.0211	.0218	.0226	.0233	.0240	.0248
-16	.0149	.0159	.0167	.0176	.0185	.0193	.0202	.0210	.0218	.0226	.0234	.0242	.0250	.0258
-14	.0153	.0162	.0172	.0181	.0190	.0199	.0208	.0217	.0225	.0234	.0242	.0250	.0259	.0267
-12	.0156	.0167	.0176	.0186	.0196	.0205	.0215	.0224	.0233	.0242	.0251	.0259	.0268	.0277
-10	0.0160	0.0171	0.0181	0.0191	0.0201	0.0211	0.0221	0.0231	0.0241	0.0250	0.0260	0.0269	0.0278	0.0287
- 8	.0163	.0175	.0186	.0196	.0207	.0217	.0228	.0238	.0248	.0258	.0268	.0278	.0287	.0297
- 6	.0166	.0178	.0190	.0201	.0212	.0223	.0235	.0245	.0256	.0267	.0277	.0287	.0297	.0307
- 4	.0169	.0182	.0194	.0206	.0218	.0229	.0241	.0252	.0263	.0275	.0286	.0296	.0307	.0317
- 2	.0172	.0185	.0198	.0210	.0223	.0235	.0247	.0259	.0271	.0283	.0294	.0306	.0317	.0328
0	0.0174	0.0188	0.0201	0.0214	0.0227	0.0240	0.0253	0.0266	0.0278	0.0291	0.0303	0.0315	0.0326	0.0338
2	.0177	.0192	.0206	.0219	.0233	.0247	.0260	.0273	.0287	.0300	.0312	.0325	.0337	.0349
4	.0179	.0194	.0209	.0223	.0238	.0252	.0266	.0280	.0294	.0307	.0320	.0334	.0347	.0359
6	.0181	.0197	.0213	.0228	.0243	.0258	.0273	.0287	.0302	.0316	.0330	.0344	.0357	.0371
8	.0182	.0199	.0215	.0231	.0247	.0262	.0278	.0293	.0309	.0323	.0338	.0352	.0367	.0381
10	0.0184	0.0201	0.0218	0.0235	0.0252	0.0268	0.0284	0.0300	0.0317	0.0332	0.0347	0.0362	0.0377	0.0392
12	.0184	.0202	.0220	.0237	.0255	.0272	.0289	.0306	.0323	.0339	.0355	.0371	.0386	.0402
14	.0184	.0204	.0222	.0240	.0259	.0277	.0295	.0312	.0330	.0347	.0364	.0380	.0397	.0413
16	.0184	.0205	.0224	.0243	.0263	.0282	.0300	.0319	.0338	.0355	.0373	.0390	.0407	.0424
18	.0183	.0204	.0225	.0245	.0265	.0285	.0304	.0323	.0343	.0361	.0380	.0398	.0415	.0434
20	0.0182	0.0205	0.0226	0.0248	0.0268	0.0289	0.0309	0.0329	0.0350	0.0369	0.0388	0.0407	0.0426	0.0445
22	.0180	.0204	.0227	.0249	.0270	.0292	.0313	.0334	.0356	.0375	.0396	.0416	.0435	.0455
24	.0179	.0203	.0227	.0250	.0273	.0296	.0317	.0339	.0362	.0383	.0404	.0425	.0445	.0466
26	.0176	.0201	.0227	.0251	.0274	.0298	.0321	.0344	.0367	.0389	.0412	.0434	.0455	.0476
28	.0172	.0199	.0225	.0251	.0275	.0300	.0324	.0348	.0372	.0395	.0419	.0442	.0464	.0486
30	0.0168	0.0195	0.0223	0.0250	0.0275	0.0302	0.0327	0.0351	0.0377	0.0400	0.0425	0.0449	0.0472	0.0496
32	.0163	.0191	.0221	.0248	.0275	.0303	.0329	.0354	.0381	.0406	.0432	.0456	.0481	.0505
34	.0158	.0187	.0217	.0246	.0274	.0303	.0330	.0357	.0385	.0410	.0437	.0464	.0489	.0515
36	.0153	.0184	.0215	.0245	.0275	.0305	.0333	.0361	.0390	.0417	.0445	.0472	.0499	.0526
38	.0146	.0177	.0210	.0241	.0273	.0304	.0334	.0362	.0393	.0421	.0450	.0479	.0506	.0534
40	0.0137	0.0170	0.0204	0.0236	0.0269	0.0302	0.0333	0.0363	0.0394	0.0423	0.0454	0.0484	0.0513	0.0541
42	.0127	.0161	.0197	.0230	.0265	.0298	.0331	.0362	.0395	.0426	.0457	.0488	.0518	.0548
44	.0119	.0154	.0192	.0227	.0262	.0297	.0331	.0364	.0398	.0430	.0463	.0495	.0526	.0557
46	.0108	.0144	.0183	.0219	.0256	.0292	.0328	.0363	.0398	.0431	.0465	.0499	.0531	.0563
48	.00972	.0135	.0176	.0213	.0252	.0290	.0327	.0362	.0399	.0434	.0469	.0504	.0538	.0572
50	0.00832	0.0122	0.0164	0.0204	0.0244	0.0283	0.0322	0.0359	0.0397	0.0434	0.0470	0.0506	0.0542	0.0577
52	.00700	.0111	.0155	.0196	.0233	.0278	.0318	.0358	.0397	.0435	.0473	.0511	.0548	.0585
54	.00526	.00948	.0141	.0184	.0227	.0268	.0311	.0352	.0392	.0432	.0471	.0511	.0549	.0587
56	.00373	.00812	.0129	.0174	.0218	.0262	.0305	.0348	.0390	.0431	.0472	.0513	.0553	.0592
58		.00663	.0115	.0162	.0208	.0253	.0299	.0343	.0387	.0430	.0472	.0515	.0556	.0597

"Freon-11"—Theoretical horsepower of refrigerating compressors

(Saturated vapor entering compressor)

Horsepower per ton

Evap Temp	Condensing temperature													
	60	65	70	75	80	85	90	95	100	105	110	115	120	125
-20	0.972	1.05	1.12	1.19	1.26	1.34	1.42	1.50	1.59	1.67	1.76	1.86	1.94	2.04
-18	.941	1.01	1.08	1.16	1.23	1.31	1.39	1.47	1.55	1.63	1.72	1.82	1.90	1.99
-16	.911	0.982	1.05	1.12	1.20	1.27	1.35	1.43	1.51	1.59	1.68	1.78	1.86	1.95
-14	.878	0.947	1.02	1.09	1.16	1.23	1.31	1.39	1.47	1.55	1.63	1.73	1.81	1.90
-12	.848	0.916	0.985	1.05	1.13	1.20	1.28	1.35	1.43	1.51	1.59	1.69	1.77	1.86
-10	0.818	0.885	0.953	1.02	1.09	1.16	1.24	1.31	1.39	1.47	1.56	1.65	1.72	1.81
- 8	.788	.855	.922	0.990	1.06	1.13	1.21	1.28	1.36	1.44	1.52	1.61	1.68	1.77
- 6	.759	.824	.891	0.958	1.03	1.10	1.17	1.24	1.32	1.40	1.48	1.57	1.64	1.73
- 4	.729	.794	.860	0.926	0.994	1.06	1.14	1.21	1.28	1.36	1.44	1.53	1.60	1.69
- 2	.700	.764	.829	0.894	0.962	1.03	1.10	1.17	1.25	1.32	1.40	1.49	1.56	1.65
0	0.672	0.735	0.799	0.863	0.930	0.998	1.07	1.14	1.21	1.29	1.36	1.45	1.52	1.60
2	.647	.710	.773	.836	.902	.970	1.04	1.11	1.18	1.26	1.33	1.42	1.49	1.57
4	.618	.681	.743	.806	.871	.938	1.01	1.07	1.15	1.22	1.29	1.38	1.45	1.53
6	.593	.655	.716	.779	.843	.908	0.978	1.04	1.12	1.19	1.26	1.34	1.41	1.49
8	.564	.627	.687	.749	.812	.877	0.943	1.01	1.08	1.15	1.22	1.31	1.37	1.45
10	0.541	0.602	0.661	0.722	0.785	0.850	0.915	0.982	1.05	1.12	1.19	1.27	1.34	1.42
12	.513	.574	.632	.692	.755	.819	.883	.949	1.02	1.09	1.16	1.24	1.30	1.38
14	.489	.549	.606	.666	.728	.792	.854	.919	0.988	1.05	1.12	1.20	1.27	1.34
16	.465	.524	.581	.640	.702	.765	.826	.891	0.959	1.02	1.09	1.17	1.24	1.31
18	.439	.497	.555	.614	.672	.734	.795	.859	0.926	0.989	1.06	1.14	1.20	1.27
20	0.415	0.473	0.531	0.589	0.646	0.708	0.768	0.830	0.897	0.961	1.03	1.10	1.17	1.24
22	.391	.448	.506	.563	.620	.681	.740	.802	.867	.930	0.998	1.07	1.13	1.21
24	.369	.425	.482	.538	.595	.655	.714	.775	.839	.902	0.968	1.04	1.10	1.17
26	.346	.401	.458	.514	.570	.630	.687	.748	.811	.873	0.939	1.01	1.07	1.14
28	.323	.378	.434	.489	.545	.604	.661	.720	.783	.844	0.909	0.981	1.04	1.11
30	0.300	0.353	0.409	0.464	0.520	0.578	0.634	0.693	0.755	0.815	0.880	0.950	1.01	1.08
32	.278	.330	.386	.439	.495	.553	.609	.666	.727	.787	.851	.920	0.979	1.05
34	.256	.308	.362	.415	.470	.528	.583	.640	.700	.759	.822	.891	0.950	1.02
36	.238	.288	.343	.396	.450	.506	.562	.618	.678	.735	.798	.866	0.924	0.990
38	.215	.265	.319	.371	.426	.481	.536	.591	.650	.708	.770	.837	0.894	0.959
40	0.194	0.243	0.296	0.348	0.402	0.457	0.511	0.566	0.624	0.681	0.742	0.808	0.865	0.928
42	.172	.220	.273	.324	.377	.431	.485	.539	.597	.653	.713	.779	.835	.897
44	.154	.201	.254	.304	.357	.411	.464	.518	.575	.630	.690	.754	.810	.872
46	.133	.180	.231	.281	.334	.386	.439	.493	.549	.604	.662	.726	.781	.842
48	.115	.162	.213	.262	.314	.366	.419	.471	.527	.582	.639	.702	.757	.818
50	0.0939	0.140	0.190	0.239	0.291	0.342	0.394	0.446	0.501	0.556	0.612	0.674	0.728	0.789
52	.0756	.122	.172	.221	.265	.322	.373	.426	.479	.533	.589	.651	.704	.764
54	.0544	.0994	.149	.195	.247	.297	.349	.401	.453	.507	.562	.622	.675	.734
56	.0370	.0816	.131	.179	.228	.278	.328	.380	.432	.485	.539	.599	.652	.710
58		.0638	.112	.160	.209	.258	.308	.359	.410	.464	.517	.576	.628	.686

SAM LEWIS' PAGE

What's In a Name?

Samuel R. Lewis, consulting mechanical engineer, and a member of HPAC's board of consulting and contributing editors, contributes informal comment on heating, piping, and air conditioning matters each month. Boiler ratings, and how to specify boilers and unit heaters, are his subjects on his page this time.

AN OUTSTANDING trend on steam boilers (judging by advertisements in trade magazines) is to increase the ratings of those boilers employed for power purposes from the conventional and long-standing basis of 10 sq ft of heating surface per horsepower to double that basis.

When a man buys a water tube boiler he may buy one rated at so many thousand pounds of water evaporated from one condition to a secondary state per unit of time.

If he analyzes the physical proportions of the boiler, however, he may find that it has about half the heat absorbing surface conventionally assumed as necessary. The old and obsolete term "horsepower" has for a long time been attempting to disappear, and to join with the term "square foot" applied to heat transmitters. There is room for improvement in nomenclature and in custom —and perhaps it will not be too unpopular for some of us to harp a bit on the subject.

A recent very detailed and elaborate specification whereby a new boiler was purchased after alleged competitive bids, called for a "500 hp" boiler. It went into details ad nauseam as to the construction of nearly every seam and rivet and as to the chemical composition of the metals.

The specification mentioned "normal rating" and asked for an output from the combined combustion apparatus and boiler of 200 per cent of rating. However, there was no stipulation that a 500 horsepower boiler means one capable at normal rating of evaporating 500 times 34.5 lb per hr of water from and at 212 deg. Even if the specification had stated that the desired performance should be to evaporate 34,500 lb per hr of water, there would be a chance for argument — if not for litigation — in the absence of any requirement for physical dimensions.

Another case involved a 350 hp oil burning, internally fired, boiler-burner unit, which upon investigation proved to be able to deliver 350 times 34.5 lb per hr of steam as promised, but that had a little less than 5 sq ft of heating surface for each of the 350 hp.

In other words the art of boiler building has advanced until almost any good boiler can deliver 1 hp with only 5 sq ft of heat absorbing area, instead of the old 10 sq ft in a water tube boiler and the old 15 sq ft in a fire tube boiler.

We do not *say* so, however, but we say "500 hp or 5000 sq ft of heating surface at 200 per cent (or some per cent) of rating". We seem to get along this way, but it seems to me that we limp, and I would like to participate in a crusade in which the "horsepower" would be employed to drag the "square feet" out of the arena.

While We're About It

While we're about it, we might discover a realistic name for a "recessed convector located in the room that is to be heated, which transmits heat to air by aid of thermal circulation of the air", and a name for a "heat transmitter located in the room that is to be heated, which has an electric fan encased with it", and which currently does not know whether it is a "unit heater" or a "heating unit."

May I specify a boiler to evaporate 34,500 lb. per hr of water and having not less than some number of square feet of heat absorbing surface?

May I specify a type (say "2" or "5", or some such number) unit heater? The suggested number describing the type of unit heater is to be selected by some code committee and is to transmit the information that type "2", for example, means a convector in vertical position, with an axial flow, direct connected, electric fan blowing through the convector, while type "5" may mean a unit heater with a belt driven centrifugal fan or fans, the fans drawing through the convector. Some other number may mean another variation in the physical construction of a unit heater.

Years ago a prominent manufacturer of hot water heaters or convectors that employ steam as the heat carrier, called the one with steam in the tubes type "K" and the one with the water in the tubes type "R". I think that this firm was a public benefactor.

Similarly, half the women in the country think that any electric food refrigerator is some editorially unquotable kind of an "Aire", and the man who was inspired to name the device some sort of cold "Aire" was another public benefactor.

NEW SYSTEM SIMPLIFIES PLANT AIR CONDITIONING

A new "integrated unit-area system" for industrial plants which is said to simplify the use, installation and maintenance of air conditioning and other equipment in "controlled conditions" factories is being introduced by the Austin Co., who 16 years ago designed and built the first plant where light, temperature, and humidity were all under full control.

The new system—result of two years of research—is based on the use of standard air conditioning and power distribution equipment in units which are predesigned to serve floor areas of almost any size.

Heating, Piping & Air Conditioning

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Journal Section

Influence of Gaseous Radiation in Panel Heating†

by F. W. Hutchinson*, Lafayette, Ind.

SUMMARY—It is often misconstrued that separating distance does not affect the rate or radiant exchange between two surfaces. Actually, radiant exchange decreases as distance increases because of absorption by the carbon dioxide and water vapor present in the intervening air space. A graphical solution is presented from which the equivalent coefficient for gaseous radiant exchange can be evaluated as a function of separating distance, vapor pressure and surface temperatures. Equations are developed to permit evaluation of radiant exchange between certain systems of surfaces when they are reflective and are separated by an absorbing medium. Gaseous radiation does not appreciably affect either the panel size or panel rating for an ordinary panel heating system, but it does reduce the effectiveness of local (direct transfer) panels by about 10 per cent.

Introduction

THE EXCHANGE of radiant energy between surfaces is usually evaluated on the assumption that the intervening medium is non-absorbing. Actually, both absorption and emission of radiation occur in room air due to the presence of carbon dioxide and of water vapor. The influence of the carbon dioxide is small and that of the water vapor is widely variable, but the combined effect of gaseous radiation in an average room and under average conditions will be shown to be of the order of 10 per cent. This value, in itself, is not insignificant, but when metal surfaced reflective materials are considered for use in panel heating, the importance of gaseous radiation is enormously magnified and, as will also be shown, becomes the controlling factor of design for reflective heating systems.

The great practical importance of gaseous radiation in connection with the use of reflective surfaces can be readily visualized by considering the boundary case of an occupant losing heat by radiation to the surfaces of a room 15 ft x 15 ft x 9 ft. If the room surfaces were thermally black, radiant loss from the occupant to his surroundings would occur at the maximum rate of approximately 160 Btu per hr. If the room surfaces were perfect reflectors and if no gaseous radiation were involved, the radiant loss from the occupant would be zero. Thus, it would appear that perfect reflectors would greatly decrease room heating requirements. By equations which are developed later in this paper, it can be shown, however, that the effect of gaseous radiant absorption in such a room would be to dissipate more than 80 per cent of the radiant energy emitted by the occupant; thus, even a perfectly reflecting surrounding (which cannot exist in practice) would conserve only 20 per cent of body radiant heat loss; in such a case neglect of gaseous absorption would alter the entire concept and lead to a completely ineffective installation.

In an actual room (15 ft x 15 ft x 9 ft) surfaced with material having a reflectivity of 90 per cent, radiant dissipation from the occupant would be 95 per cent of the maximum possible loss of which 50.3 per cent would be by gaseous absorption. In a similar room with reflectivity of 80 per cent, the total radiant loss would be in excess of 98 per cent of the maximum. Thus in any room of average size, the value to conservation of body

*Professor of Mechanical Engineering, Purdue University, Lafayette, Ind.

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heat of surfacing with any commercially available reflective foil would be less than 2 per cent; this figure decreases rapidly as room size increases.[1]

From the standpoint of total energy requirements of the average non-reflective panel heating system gaseous radiation is relatively unimportant. It is responsible for approximately a 10 per cent decrease in the radiant effect of the panel and a consequent increase in the convective fraction of energy dissipation. For a ceiling panel, the convective increase is of the order of 25 per cent whereas, for wall or floor panels it is of the order of 14 per cent and 9 per cent, respectively. The absolute value of the increase of convection is, of course, the same for all panel locations, but the fractional increase is much greater for ceiling panels which normally have a low absolute convection loss.

In industrial installations, or for any local heating panels which are designed to irradiate the subject at a given rate, the average effect of absorption is to necessitate a 10 per cent increase in the design area of the panel. It should be noted particularly that this size-increment applies only to local units; general heating panels sized by the usual methods need not be corrected for size, but will have to be corrected for performance differences due to greater air heating effect.

Equivalent Gaseous Radiation Coefficient

I. *Water Vapor.* Standard references on heat transfer[2] provide data on the emissive power of water vapor and of carbon dioxide as functions of the vapor pressure, the gas temperature and the mean length of path through the gas. For water vapor at temperatures such as occur in panel heating, the emissive power can be expressed by the following equation:

$$E = aT_g^{3.54}$$

where,

E = emissive power of water vapor, Btu/(hr) (sq ft)
T_g = absolute temperature of gas, deg
a = a coefficient which varies as a function of the product PL
P = partial pressure of the water vapor expressed as a fraction of atmosphere
L = beam length, varying from ⅔ of the diameter for a sphere to 1.3 times the ceiling height for a room of proportions 1 × 2 × 6 in which radiation is to one of the large faces.[3]

For rooms of average size and shape, with radiation considered as occurring from a ceiling or a floor panel, the value of L can conveniently, and with accuracy, be taken as equal to the ceiling height. The partial pressure of water vapor in room air is fixed when the absolute humidity is known; hence can be expressed as a function of room air temperature and relative humidity as two conveniently measurable variables.

In evaluating radiant exchange between surfaces separated by a non-absorbing medium, it has been found convenient to use an equivalent film coefficient for radiation, h_r, defined as,

$$h_r = \frac{0.172\left[\left(\frac{T_h}{100}\right)^4 - \left(\frac{T_c}{100}\right)^4\right]}{t_h - t_c} \qquad (1)$$

[1] Panel Heating and Cooling Performance Studies, by B. F. Raber and F. W. Hutchinson. (ASHVE TRANSACTIONS, Vol. 48, 1942 pp. 35-44.)
[2] Heat Transmission, by McAdams.
[3] Loc. cit, p. 63.

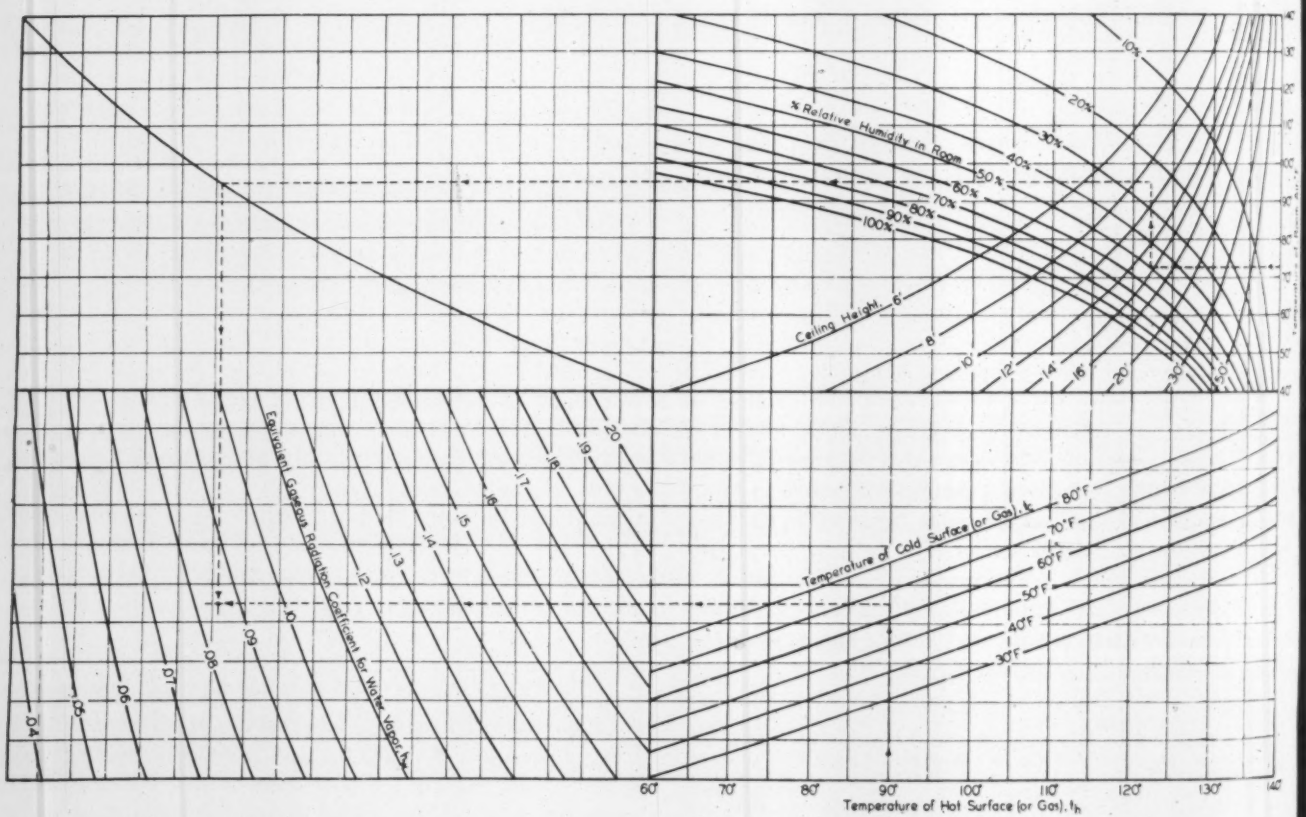


Fig. 1—Graphical solution of Equation 2 for determining equivalent coefficient for radiation to or from water vapor

where
h_r = equivalent film coefficient for radiation, Btu per (sq ft) (hr) (F deg)
T_h = absolute (F) temperature of *hot* surface
T_c = absolute (F) temperature of *cold* surface
t_h = temperature (F) of *hot* surface
t_c = temperature (F) of *cold* surface.

A similar equivalent coefficient for radiation to or from water vapor is,

$$h_w = \frac{a\,(T_h^{3.54} - T_c^{3.54})}{t_h - t_c} \quad \ldots\ldots (2)$$

where,
h_w = equivalent film coefficient for radiation to or from water vapor, Btu per (sq ft) (hr) (F deg)

Fig. 1 is a graphical solution of Equation 2. Use of the graph can best be explained by means of an example: In a room with air at 72 F, 50 per cent relative humidity, to evaluate the absorption by the water vapor of radiation from a surface at 83 F; ceiling height is 9 ft.

Solution: Enter the upper right quadrant at 72 F and move horizontally left to intersect the 50 per cent RH line (see dashed example on graph) then rise to the curve for 9 ft ceiling height, move horizontally left to the directrix and drop vertically to the lower left quadrant. Now re-enter the chart in the lower right quadrant at the 83 F surface temperature, rise to 72 F air temperature and move horizontally left to intersect the previously established vertical at a value of $h_w = 0.086$. Thus the transfer rate to the gas by radiation is $0.086(83 - 72) = 0.95$ Btu per sq ft.

II. *Carbon Dioxide.* The emissive power for carbon dioxide is given by an equation similar to that for water vapor, but with an exponent of 5.3 and a different functional relationship between the coefficient "*a*" and the value of *PL* for CO_2. The partial pressure of CO_2 in outside air is 0.0003 and in the air of an occupied space its partial pressure reaches an equilibrium value dependent on the ventilation rate. Taking 0.6 cfh as the CO_2 output of an occupant and taking 10 cfm per occupant as the minimum outside air used for ventilation, the equilibrium CO_2 concentration, X, is given by

$$0.0003 \times 10 \times 60 + 0.6 = 60 \times 10X$$
$$X = 0.0013 \text{ (or 0.13 per cent)}$$

Taking $L = 10$, "*a*" is 7.6×10^{-15} and the value of the equivalent coefficient for exchange between a 120 F panel and 60 F gas is approximately 0.025 Btu per (hr) (sq ft) (F deg). Values of this coefficient greater than 0.025 are unlikely to occur in panel heating practice and since the coefficient is small with respect to usual values of the water vapor coefficient, it is suggested that a fixed conservative value of 0.02 be used for all average cases.

III. *Total Gaseous Radiation.* An equivalent gaseous radiation coefficient, h_g, can now be defined by the equation,

$$h_g = h_w + 0.02 \quad \ldots\ldots (3)$$

where,
h_g = equivalent gaseous radiation coefficient, Btu per (sq ft) (hr) (F deg)
h_w = equivalent water vapor radiation coefficient, Btu per (sq ft) (hr) (F deg)

where h_w is determined by Fig. 1. For many practical problems, the coefficient can be further simplified by selecting representative average temperatures and thereafter neglecting the effect on h_g of the temperature. Similarly, *standard* room conditions can be selected, the ceiling height fixed and a single value of h_g thereby obtained which will be applicable to most problems. For room air at 72 F, 50 per cent relative humidity with 9 ft ceiling and the temperatures arbitrarily fixed at 65 F and 90 F the value of h_w from the graph (see dashed example line in Fig. 1) is 0.086 and the corresponding value of the total gas coefficient h_g is,

$$h_g = 0.11$$

When the statement of a problem does not permit exact evaluation of the conditions of gaseous radiant exchange, it is recommended that the value of the coefficient given previously be used.

In similar manner, a fixed value of the equivalent radiation coefficient for transfer through a non-absorbing medium is frequently used. For the temperature range common in panel heating, the value of this constant has been taken as 1.08. Thus for an *average* room under *average* panel heating conditions, the effect of gaseous absorption is to reduce the energy exchange by radiation between the heating panel and the surroundings by

$$0.11/1.08 = 10 \text{ per cent}$$

For convenience in the analyses of the following section, the difference between unity and the fraction of absorbed radiant energy will be defined as the transmissivity, γ; for standard conditions 90 per cent of the energy emitted is transmitted so the corresponding value of γ is 0.90.

Basic Exchange Equations with Gaseous Radiation Considered

If all surfaces of practical importance were thermally *black bodies*, the gaseous radiation coefficient from the preceding section could be used as a direct indication of the importance of transfer between a surface and the ambient air. In many cases, however, thermally *gray* surfaces, and metallic surfaces of high reflectivity, must be considered. When these conditions occur, the importance of gaseous absorption increases at a very rapid rate since the average unit of thermal energy emitted by the source will traverse the space between source and receiver more than once. Hence equations must be established from which the additional increments of gaseous absorption, associated with inter-reflections and re-reflections in the system composed of source and receiving surfaces, can be evaluated.

As in most practical problems, a satisfactory rational solution can only be obtained in terms of a simplifying idealization. The variety of shapes and surface characteristics of real rooms are so great, and the possible combinations so complex, that no accurate generalized solution can be found. Recourse is had, therefore, to an idealization which will give an approximation to results for the general case and an exact solution of certain particularly important boundary cases. Consider, for example, energy exchange between the shells of two concentric spheres: As the inner sphere becomes small with respect to the outer, the ratio of surface areas

approaches zero and the system becomes equivalent to that represented by an element of area, dA_1, of an enclosure; the quantity of energy initially emitted by dA_1 and later re-absorbed is negligible, but the influence of reflectivity of the surroundings on total gaseous absorption remains great. If, however, the inner sphere becomes large with respect to the outer the fraction of energy reflected from A_2 and returning to A_1 approaches unity; this system becomes similar to one involving infinite parallel planes.

For values of the area ratio between zero and unity, the concentric spheres can be shown to form a system similar to that of concentric cylinders of infinite length and they also form a system from which one can approximate the exchange of body heat between an occupant and a uniform surrounding. Thus an exact rational solution for the idealization of concentric spheres will be of value in approximating a solution to many practical problems. As a first step toward development of such a solution, it may be noted[4] that (A_1/A_2) of the energy reflected from A_2 is returned in the direction of the inner sphere.

I. To determine the net fraction, F_1, of *black body* radiation initially emitted by the outside surface of a sphere of area A_1 and either absorbed by the inside surface of a larger concentric sphere of surface area A_2 or absorbed by the water vapor and carbon dioxide contained in the air in the space between the two spheres. Thus,

Net initially emitted radiant energy leaving A_1 is the total emission from A_1 minus energy re-absorbed after reflection or,

$$q_1 = q_e - q_r$$

now, q_e, the emissive power $= a_1 \sigma T_1^4 = E_1$

where,

a_1 = emissivity of surface A_1
a_2 = emissivity of surface A_2
$\sigma = 0.173 \times 10^{-8}$

Energy striking A_2 for the first time and returned in the direction of A_1 is,

$$E_1 A_1 \gamma^2 (1-a_2) (A_1/A_2)$$

where,

γ = transmissivity of the room air to radiant energy's difference between unity and the gaseous absorption fraction.

Energy striking A_2 for the first time and reflected in the direction of A_1 is,

$$E_1 A_1 \gamma^2 (1-a_2) (1-A_1/A_2)$$

Energy striking A_2 for the second time after one reflection from A_2 and then returned in the direction of A_1 is,

$$E_1 A_1 \gamma^3 (1-a_2)^2 (1-A_1/A_2) (A_1/A_2)$$

Energy striking A_2 for the second time after one reflection from A_2 and then reflected in the direction of A_2 is,

$$E_1 A_1 \gamma^3 (1-a_2)^2 (1-A_1/A_2)^2$$

[4]Heat Transfer Notes by Boelter, Cherry and Johnson. University of California Press, Chapter XVIII, section 11d.

The total energy returned in direction of A_1 for the first time is then,

$$E_1 A_1 \gamma^2 (1-a_2) (A_1/A_2) \left[1 + \gamma (1-a_2) (1-A_1/A_2) + \cdots + \gamma^n (1-a_2)^n (1-A_1/A_2)^n \right] = \frac{E_1 A_1 \gamma^2 (1-a_2) (A_1/A_2)}{1-\gamma (1-a_2) (1-A_1/A_2)}$$

The energy initially emitted by A_1 and leaving for a second time is,

$$\frac{E_1 A_1 \gamma^2 (1-a_2) (A_1/A_2) (1-a_1)}{1-\gamma (1-a_2) (1-A_1/A_2)}$$

and the energy returned in the direction of A_1 for the second time is,

$$\frac{E_1 A_1 \gamma^3 (1-a_2) (A_1/A_2)}{1-\gamma (1-a_2) (1-A_1/A_2)} \cdot \left[\frac{\gamma^2 (1-a_1) (1-a_2) (A_1/A_2)}{1-\gamma (1-a_2) (1-A_1/A_2)} \right]$$

so the energy returned in the direction of A_1 for the nth time is,

$$\frac{E_1 A_1 \gamma^2 (1-a_2) (A_1/A_2)}{1-\gamma (1-a_2) (1-A_1/A_2)} \cdot \left[\frac{\gamma^2 (1-a_1) (1-a_2) (A_1/A_2)}{1-\gamma (1-a_2) (1-A_1/A_2)} \right]^{n-1}$$

Thus the *total* energy initially emitted by A_1 and returned in the direction of A_1 after multiple reflections is,

$$\frac{E_1 A_1 \gamma^2 (1-a_2) (A_1/A_2)}{1-\gamma (1-a_2) (1-A_1/A_2)} \cdot \left\{ \frac{1}{1 - \dfrac{\gamma^2 (1-a_1) (1-a_2) (A_1/A_2)}{1-\gamma (1-a_2) (1-A_1/A_2)}} \right\}$$

or,

$$\frac{E_1 A_1 \gamma^2 (1-a_2) (A_1/A_2)}{1-\gamma (1-a_2) (1-A_1/A_2) - \gamma^2 (1-a_1) (1-a_2) (A_1/A_2)}$$

and the energy re-absorbed is a_1 times the above quantity. Then the net fraction of black body energy leaving A_1 is,

$$F_1 = a_1 - \frac{a_1^2 \gamma^2 (1-a_2) (A_1/A_2)}{1-\gamma (1-a_2) (1-A_1/A_2) - \gamma^2 (1-a_1) (1-a_2) (A_1/A_2)}$$

$$F_1 = \frac{a_1 \left\{ (1-\gamma+a_2\gamma) \left[1 + \gamma (A_1/A_2) \right] - a_2 \gamma (A_1/A_2) \right\}}{1-\gamma (1-a_2) \left[1 - (A_1/A_2) + \gamma (A_1/A_2) - a_1 \gamma (A_1/A_2) \right]} \quad \ldots (4)$$

II. To determine the net fraction, Fr, of *black body* radiation initially emitted by the outside surface of a sphere of area A_1 and absorbed by the inside surface of a larger concentric sphere of surface area A_2.

Total energy received at A_2 of that initially emitted by A_1

= (Direct from A_1 with zero to infinite inter-reflections at A_2)
+ (Second time from A_2 with zero to infinite inter-reflections at A_2)
+ ——— + ——— +
+ (Infinite times from A_2 with zero to infinite inter-reflections at A_2)
= (A) + (B) + ——— + (N)

By inspection (following the procedure of the derivation in part I),

$$(A) = E_1 A_1 \gamma a_2 + \frac{E_1 A_1 \gamma^2 (1-a_2) \left[1 - (A_1/A_2) \right] a_2}{1-(1-a_2) \gamma \left[1-(A_1/A_2) \right]}$$

$$(B) = (A) \cdot \left\{ \frac{\gamma^2 (1-a_2) (1-a_1) (A_1/A_2)}{1-(1-a_2) \gamma \left[1-(A_1/A_2) \right]} \right\}^2$$

$$(N) = (A) \left\{ \text{———} \right\}^{n-1}$$

The total energy received at A_2 is then,

$$\frac{E_1A_1\gamma a_2+\dfrac{E_1A_1\gamma^2(1-a_2)\left[1-(A_1/A_2)\right]a_2}{1-(1-a_2)\gamma\left[1-(A_1/A_2)\right]}}{1-\dfrac{\gamma^2(1-a_1)\,(1-a_2)\,(A_1/A_2)}{1-(1-a_2)\gamma\left[1-(A_1/A_2)\right]}}$$

and the net fraction of black body radiation emitted by A_1 which is absorbed by A_2 is,

$$F_r=\frac{a_1a_2\gamma}{1-\gamma(1-a_2)\left[1-(A_1/A_2)+\gamma(A_1/A_2)-a_1\gamma(A_1/A_2)\right]} \quad \ldots\ldots(5)$$

III. To determine the net fraction, F_a, of *black body* radiation initially emitted by the outside surface of sphere A_1 and absorbed by the water vapor and carbon dioxide in the air in the space external to this sphere but inside a larger concentric sphere.

The fraction of black body energy leaving A_1, (I), less the fraction received at A_2, (II), must be equal to the fraction absorbed, thus,

$$F_a=F_1-F_r$$

$$=\frac{a_1\left\{(1-\gamma+a_2\gamma)\left[1+\gamma(A_1/A_2)\right]-a_2\gamma(A_1/A_2)-a_2\gamma\right\}}{1-\gamma(1-a_2)\left[1-(A_1/A_2)+\gamma(A_1/A_2)-a_1\gamma(A_1/A_2)\right]} \quad \ldots\ldots(6)$$

IV. Check on the three basic equations:—

1. If gaseous absorption is neglected $\gamma = 1$ and the equations become:

$$F_1=F_r=\frac{a_1a_2}{\dfrac{1}{a_1}+(A_1/A_2)\left[\dfrac{1}{a_2}-1\right]} \quad \ldots\ldots(7)$$

which is the shape factor for concentric spheres.[5]

2. If the inner sphere is very small with respect to the outer, the ratio A_1/A_2 approaches zero and

$$F_1=\frac{a_1(1-\gamma+a_2\gamma)}{1-\gamma(1-a_2)} \quad \ldots\ldots(8a)$$

$$F_r=\frac{a_1a_2\gamma}{1-\gamma(1-a_2)} \quad \ldots\ldots(8b)$$

$$F_a=\frac{a_1(1-\gamma)}{1-\gamma(1-a_2)} \quad \ldots\ldots(8c)$$

3. If the inner sphere is large with respect to the outer, the ratio A_1/A_2 approaches unity and

$$F_1=\frac{a_1(1-\gamma^2+a_2\gamma^2)}{1-\gamma^2(1-a_2)\,(1-a_1)} \quad \ldots\ldots(9a)$$

$$F_r=\frac{a_1a_2\gamma}{1-\gamma^2(1-a_2)\,(1-a_1)} \quad \ldots\ldots(9b)$$

$$F_a=\frac{a_1(1-\gamma^2-a_2\gamma^2-a_2\gamma)}{1-\gamma^2(1-a_1)\,(1-a_2)} \quad \ldots\ldots(9c)$$

[5]Heat Transmission by McAdams (1st Edition, p. 54, case 5).

Applications of the Exchange Equations

I. Influence of gaseous absorption in a room in which all surfaces are assumed perfect reflectors ($a_2=0$) and the occupant is considered to have an emissivity of 0.9:—To calculate the percentage of radiant energy emitted by the occupant and absorbed by the gas,

1. If there were no gaseous absorption ($\gamma = 1.0$) the energy loss from the occupant would be (Equation 7),

$$F_1 = 0$$

2. With gaseous absorption, the loss is given by Equation 4 and F_a is equal to F_1. The magnitude of the loss will depend on room size since for larger rooms the average unit of radiation will have to undergo a greater number of inter-reflections between room surfaces before being returned to the occupant. For a room 15 ft × 15 ft × 9 ft (having 990 sq ft of surface area): By Equation 4, $F_1 = 0.9 \times 0.802$, or 80 per cent is absorbed.

II. Radiant loss from occupant to an enclosure having a reflectivity of 90 per cent. (Size 15 ft x 15 ft x 9 ft).

By Equation 6, $F_a = 0.9 \times 0.503$
By Equation 5, $F_r = 0.9 \times 0.445$
Loss = 0.9×0.948 or 95 per cent of emitted energy

III. Radiant loss from occupant to an enclosure (15 ft x 15 ft x 9 ft) having a reflectivity of 80 per cent.

By Equation 4, $F_1 = 0.9$ x 0.98 or 98 per cent of emitted energy.

This case represents conditions comparable to the best obtainable with reflective surfacings. Although reflectivities in excess of 80 per cent are available, such materials are unsuitable for use on floors and even if all walls and the ceiling (ignoring, for the moment, windows) were covered with such surfacing, the *equivalent* reflectivity of the surrounding surfaces would, in almost every case, be less than 80 per cent.

Summary and Conclusion

It is a popular misconception that separating distance (aside from its effect on shape factor) does not affect the rate of radiant exchange between two surfaces. Actually, radiant exchange decreases as distance increases because of absorption by the carbon dioxide and water vapor present in the intervening air space. A graphical solution is presented from which the equivalent coefficient for gaseous radiant exchange can be evaluated as a function of separating distance, vapor pressure (expressed in terms of room air temperature and of relative humidity) and surface temperatures. Equations are developed to permit evaluation of radiant exchange between certain systems of surfaces when they are reflective and are separated by an absorbing medium.

Gaseous radiation does not appreciably affect either the panel size or panel rating for an ordinary panel heating system, but it does reduce the effectiveness of local (direct transfer) panels by about 10 per cent. Because of cumulative absorption as associated with multiple reflections, gaseous radiation is responsible for reducing the effectiveness of reflective surfaces (when used as room surfacing in an attempt to reduce radiant body heat loss) to a negligible value; thus use of commercial foil for surfacing a room larger than 15 ft x 15 ft x 9 ft would conserve only about 2 per cent (3 Btu per hr) of body heat.

Throw of Air from Slots and Jets

By Richard D. Madison* and Walter R. Elliot**, Buffalo, N. Y.

SUMMARY—Solution of air distribution problems involving determination of residual velocity, entrainment ratio, effective diameter, size of openings for jets and slots having aspect ratios up to 40:1 will be simplified by use of the charts presented in this paper. These charts are based upon data given in previous reports of ASHVE cooperative research at Case School of Applied Science.

USING the ASHVE cooperative research work of G. L. Tuve, G. B. Priester and D. K. Wright, Jr. at Case School of Applied Science[1,2] as a source of data the authors have developed two charts which are designed to provide graphical solution of problems involving the determination of the throw of air from slots and jets; the residual velocity; and the size of openings. The charts apply only to air discharging into room air of same temperature as the stream. They can be used to determine the throw of air and entrainment ratio for jets and slots with aspect ratios up to 40:1 with initial velocities of 1000 to 6000 fpm and with residual velocities of 100 to 1000 fpm.

Air Flow from Slots and Jets

The following facts have been ascertained with regard to the flow of air from slots and jets[3]:

1. The length of the throw of a stream of air issuing from a slot, and the shape of the stream are nearly independent of the shape of the outlet.

2. Beyond 20 diameters from the outlet as long as the maximum residual velocity of the air stream is over 500 fpm, the residual velocity is directly proportional to the outlet velocity and inversely proportional to the distance from the outlet. With a maximum residual velocity below 500 fpm a suitable correction factor is incorporated into the value of K.

3. The ratio of the maximum residual velocity to the average residual velocity of an air stream varies from about 2.4:1 to 3:1 depending on the measuring instrument used.

4. The coefficient of discharge for a sharp-edged opening is about 0.61 for round openings and increases with increasing aspect ratio. The coefficient of discharge for standard grilles is considerably higher, and for orifices with well-rounded entrances, approaches unity.

5. The angle of divergence of the air jet is practically constant regardless of the aspect ratio of the opening.

Development of Charts

The fundamental equations from which the curves in Fig. 1 were plotted are:

$$V_r = \frac{K\ V_o \sqrt{A_e}}{X} \qquad (1)$$

Entrainment Ratio =

$$\frac{0.785\ K}{RX\sqrt{A_e}}\left[\sqrt{\frac{A_e}{0.785}} + 0.35\ X\right]^2 - 1 \qquad (2)$$

(with 20 deg jet angle)

where

V_r = maximum residual velocity in air stream, fpm

V_o = Average initial velocity across outlet, fpm

K = Constant of proportionality given in the original paper in tabular form and used in plotting the curves

A_e = Effective area of outlet, sq ft

R = Ratio of maximum residual velocity to average residual velocity

X = Normal distance from outlet face, ft

Elimination of X from the foregoing equations and insertion of an average value for R as obtained by several investigators independently results in:

Entrainment Ratio =

$$0.314\frac{V_r}{V_o}\left[1.12 + 0.35\ K\left(\frac{V_o}{V_r}\right)\right]^2 - 1 \qquad (3)$$

As established in the original research work K is a direct function of (V_o/V_r) and therefore the entrainment ratio is a function of (V_o/V_r). Equation 3 is plotted in Fig. 1 with V_r as the abscissa and entrainment ratio as the ordinate, with curves representing V_o sloping downward to the right.

The length of throw in effective diameters can be obtained by substituting the effective diameter D_e for the effective area in Equation 1.

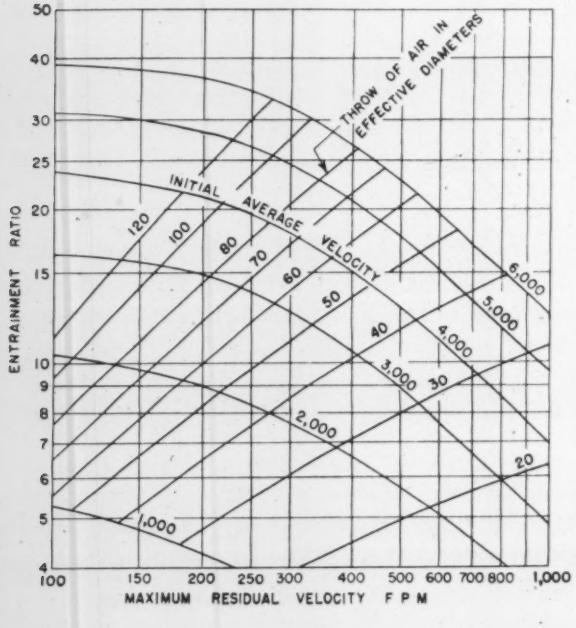


Fig. 1 — Relation between initial velocity, residual velocity, entrainment ratio and throw of air from jets and slots

*Research Engineer, Buffalo Forge Co. Member of ASHVE.

**Dept. of Experimental Engineering, Buffalo Forge Co.

[1]ASHVE RESEARCH REPORT No. 1204—Entrainment and Jet-Pump Action of Air Streams, by G. L. Tuve, G. B. Priester and D. K. Wright, Jr. (ASHVE TRANSACTIONS, Vol. 48, 1942, p. 24.)

[2]ASHVE RESEARCH REPORT No. 1248—Control of Air-Streams in Large Spaces, by G. L. Tuve and G. B. Priester. (ASHVE TRANSACTIONS, Vol. 50, 1944, p. 153.)

[3]Loc. Cit. See Notes 1 and 2.

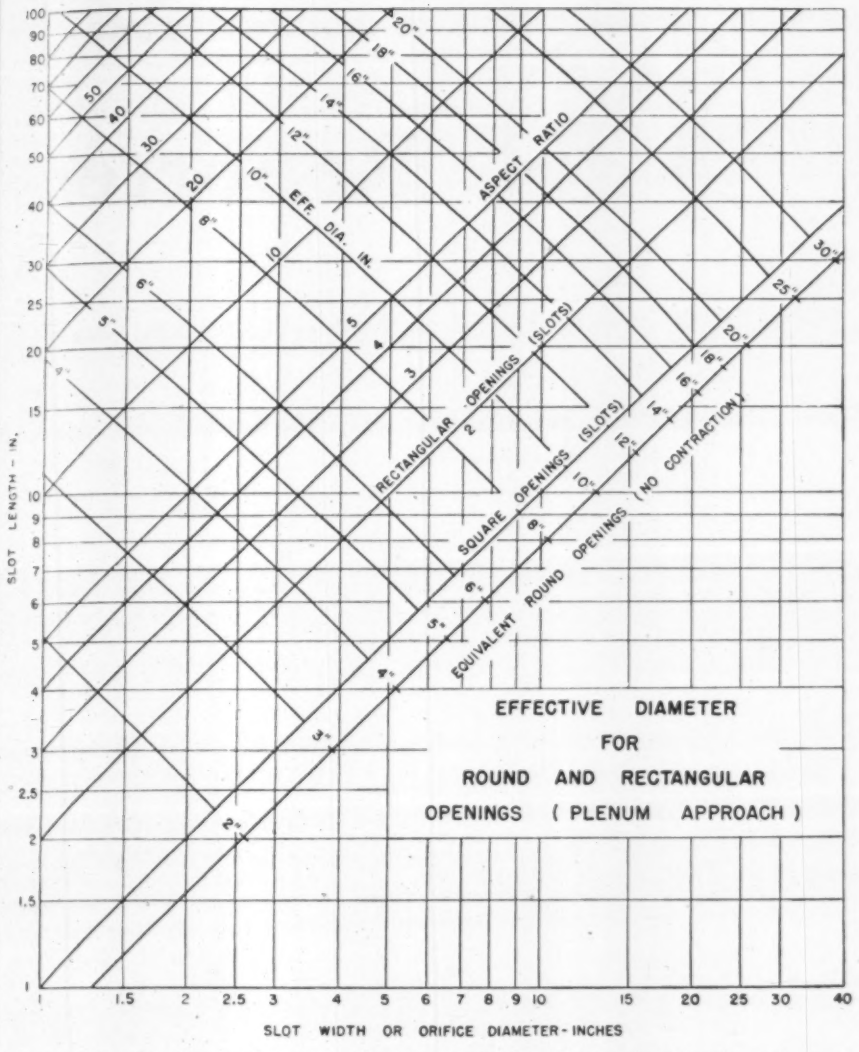


Fig. 2—**Effective diameter for round and rectangular air openings having plenum approach**

The curves of effective diameter slope upward to the right on Fig. 1.

Equation 1 may be rewritten

$$X = K\frac{V_o}{V_r}\sqrt{A_e} \quad \ldots\ldots (4)$$

$$= 0.886K\frac{V_o}{V_r}D\sqrt{\text{coeff. of discharge}}$$

where
D = actual diam of opening

The distance in effective diameters =

$$\frac{X}{D\sqrt{\text{coeff. of discharge}}} = \frac{X}{D_e}$$

$$= 0.886\ K\frac{V_o}{V_r} \quad \ldots\ldots (5)$$

where
D_e = effective diam.

$$= D\sqrt{\text{coeff. of discharge}}$$

As in Equation 3, K is a function of $\frac{V_o}{V_r}$ and hence $\frac{X}{D_e}$ is a function only of $\frac{V_o}{V_r}$.

The effective diameter of an opening of any shape may be obtained without calculating the area of the opening or substituting a value for K, by use of Fig. 2 which has been constructed for graphical determination of the effective diameter for an opening of any aspect ratio. For example: For an orifice 6 in. in actual diameter read as an abscissa, an effective diameter of 4.7 in. is read vertically above at the intersection of the vertical 6 in. diameter line with the 4.7 in. effective diameter line and the equivalent round opening line. Also, as read from Fig. 2, a slot 3 in. x 20 in. has an effective diameter of 6.9 in. The charts as plotted are for use with sharp-edged orifices or slots, and *include the coefficient of discharge*. If air is discharged from an orifice with a well-rounded entrance or from a length of straight duct, the coefficient of discharge is unity and the actual area of the opening is the effective area. For such rectangular openings the effective diameter is the diameter of a circle with an area equal to the actual area of the rectangle.

Illustrative Examples

The following examples will illustrate the use of the charts:

Example 1: Air is delivered to a cooler through independent slots each 24 in. x 2 in. with an initial velocity of 2000 fpm. Determine the maximum residual velocity and the entrainment ratio at a distance of 15 ft from the slot.

From Fig. 2 the effective diameter = 6.2 in. = 0.52 ft. The number of effective diameters in 15 ft = 15/0.52 = 28.8.

From Fig. 1 at 2000 ft initial velocity and 28.8 effective diameters read entrainment ratio = 6.6 and maximum residual velocity = 390 fpm. From tests it has been shown that the *average* residual velocity may be taken as 1/3 of the *maximum* or 130 fpm in this case.

Example 2: Using the data from *Example 1* determine the distance at which the maximum residual velocity will be 150 fpm.

From Fig. 1 at $V_o = 2000$ and $V_r = 150$, the number of effective diameters is read directly as 73 and the throw of the air is therefore $73 \times 0.52 = 38$ ft.

Example 3: Air issues from a round orifice plate with an initial average velocity of 4000 fpm. It is to have a maximum residual velocity of 400 fpm at a distance of 30 ft from the opening. Calculate the size of opening required and the entrainment ratio.

On Fig. 1 at the intersection of the curve of 4000 fpm and residual velocity of 400 fpm, the entrainment ratio is read directly as 15 and the effective diameters of throw = 55.

Since 55 effective diameters are equal to 30 ft as required, 1 effective diameter $= \frac{30}{55} = 0.545$ ft. or 6.56 in.

On Fig. 2 vertically below intersection of 6.56 in. effective diameter line and equivalent round opening line read 8.5 in. in lower margin.

Example 4: A jet of air issues from a pipe or from an orifice having a well-rounded entrance (coefficient of discharge = 1.0) and delivers air with the same velocities and with the same throw as in *Example 3*. What is the required diameter?

In this case since the coefficient of discharge is unity, the effective diameter of the jet is the actual diameter of the pipe or orifice, or 6.56 in., as obtained in *Example 3*.

Research Reporter

EXECUTIVE COMMITTEE PLANS 1947 RESEARCH PROGRAM AND ADOPTS BUDGET

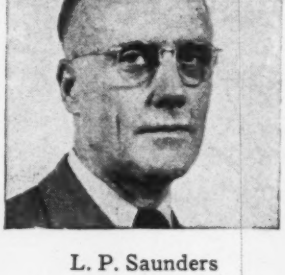
MEETING at Cleveland on September 21, 1946 under the Chairmanship of L. P. Saunders, the Research Executive Committee approved the budget for research operations in the 1947 fiscal period.

Work at the Laboratory in Cleveland during 1947 will include the continuation of experimental studies on solar radiation transmission and heat transfer coefficients for plain and ribbed surfaces; the completion of studies on the volumetric specific heat, emissivity, and absorptivity of building materials and the development of design tables for periodic heat flow through building construction. Studies will be made on friction in square and rectangular ducts and in various types of fittings, using equipment now being assembled at the Laboratory. Studies on barometric dampers will be continued, and it is expected that a special research bulletin on flow losses in conduits will be completed. Plans for Laboratory activities in the field of radiant heating are discussed elsewhere on these pages. One important problem to be attacked is the preparation of comprehensive and statistically-sound weather design data for areas covered by a large number of the principal weather stations throughout the country.

At the cooperating institutions, sudies on air distribution from slots and grilles will be actively pursued at Case School, while at Kansas State College fundamental studies on the downblow of air streams are to be continued. Work on the heat transfer coefficients of Freon refrigerants will also continue at Case School. At the University of Toronto studies on the measurement of the dewpoint of air-vapor mixtures will be completed. The University of Illinois Medical School in Chicago will continue the important studies on entering and leaving shock effect.

Other projects of interest and practical value to the membership are in the planning stage; they will be activated as funds and personnel permit.

Research Executive Committee



L. P. Saunders
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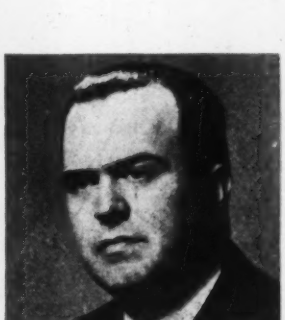

L. N. Hunter

PLAN TO VISIT THE RESEARCH LABORATORY IN JANUARY

THE IMPORTANCE OF SCIENTIFIC RESEARCH IN THE POSTWAR ERA*

Though there are said to be at least 2,264 industrial research laboratories in this country, too many corporations have set up what they call research laboratories, which are merely developmental and trouble shooting laboratories. It is not easy for a board of directors to decide to invest funds, labor, and equipment when some direct, immediate return cannot be seen; yet that type of faith and imagination is what is required if the greatest financial return is to be realized. The greatest practical returns from research come when one is willing to cast his bread upon the waters and relax, as far as that particular bread is concerned, secure in the knowledge that eventually it will return manyfold.

In years past, it was difficult to convince a board of directors that they should make contributions which would enable a *dreamy* scientist to work in his laboratory at whatever he pleased. If they had not come to see that no apparently isolated fact is useless, and that the non-availability of any particular bit of information may later make impossible the solution of a specific problem, American prosperity would be on a far lower level than it is.

Fundamental research is now, however, becoming a profitable undertaking for some of the larger corporations.

When someone succeeds in inventing a gun which will shoot a bullet around a corner, it may become reasonable to expect to predict the outcome of any individual piece of research—that is, of real research as distinct from mere development. Progress in science is almost always made around corners instead of in straight lines. Most great discoveries have been made out of the corner of someone's eye. The most successful research laboratories are those in which funds are allotted to support research activities, a crew is set to work, and then everyone stops worrying about whether any particular job is going to pay back its cost in one year or ever.

Several years ago, Dr. Karl Compton told the *National Association of Manufacturers* that 2 per cent of the gross income of any industry could be expended effectively on research. Since then, this advice has been amply borne out, and the world has been plunged into a war in which the value of research has been demonstrated for all to see, as the strength of nations has been primarily their scientific and industrial strength.

*Extracted from a talk by Dean George R. Harrison, Massachusetts Institute of Technology.

RADIATION AND COMFORT

The Technical Advisory Committee on Radiation and Comfort met at the ASHVE Laboratory, Cleveland on September 21 under the Chairmanship of J. C. Fitts. Members of the committee on Panel Heating of the *Heating, Piping and Air Conditioning Contractors National Association* and a representative of the *National Research Council* of Canada joined in the discussions.

J. C. Fitts
Chairman

The committee agreed that the most urgent problem facing the industry today was the development of practical and generally acceptable design data for radiant heating installations. This can be aided by the close cooperation of interested parties and the pooling of all available information. The committee recommended that a careful search of the literature and a survey of the activities of all those working in the field be undertaken before any additional experimental program is planned for the Laboratory.

Field studies in homes using radiant heating are planned for the winter of 1946-47.

The *National Research Council* of Canada has erected two test rooms to study the various methods used in radiant heating, and studies will be made under the severe winter conditions usually experienced in Ottawa.

The Committee on Research has a research program on radiant heating under way at Manhattan, Kansas under a cooperative agreement with Kansas State College. A test room, 10 ft 6 in. square, has been built within a larger room and equipment installed to control the surface temperatures of the floor and of any one wall or the ceiling. When instrumentation is completed, tests to determine sensory reactions to a variety of conditions will be undertaken. During the construction of the room, Prof. Linn Helander and his colleagues have been carrying on theoretical studies on the emissivity of unheated surfaces as a factor in the design of radiant heating systems. Reports are now in preparation.

ARMY LABORATORY TO STUDY MAN'S PHYSIOLOGICAL NEEDS†

In order to provide the clothing and equipment designers with fundamental information, the Quartermaster Corps has established and is expanding in the postwar era a basic laboratory for investigation of physiology and the environmental protection of man. In the study of the greatest engineering mechanism of all, the human body, we are finding out daily new facts, many of which upset our preconceived notions. How many realize that under hot humid conditions we may give off as much as two liters of sweat per hour? The interaction of clothing on this process of perspiration may be of major importance in solving the problem of heat prostration. Even sitting in relative comfort and equilibrium, an individual gives off close to 500 grains of water vapor per hour! If the process of evaporation is unduly accelerated, one feels cold; under similar conditions the soldier may become a casualty.

On the other hand, if normal perspiration is not allowed to pass away, it collects in the clothing as condensed moisture and lowers the insulation value. Everyone has experienced conditions where he felt wetter from body moisture inside an impermeable raincoat than would seem possible by standing unprotected in the rain. This factor is intimately connected with one of the most serious medical problems of troops in wet-cold conditions, which is known popularly as trench foot. Heat transfer, vapor pressure, moisture-vapor transfer, K factor, latent heat, thermodynamics, common phrases in the vocabulary of the power-plant engineer, have become the very basis for scientific clothing design.

†Extract from address by Col. William H. McLean, Research and Development Branch Office of Quartermaster General, U. S. Army, Washington, D. C., delivered at the Annual Meeting of the *American Society of Mechanical Engineers*, November 1945, New York, N. Y.

PLAN TO VISIT THE RESEARCH LABORATORY IN JANUARY

Terminal Tower

MAKE PLANS NOW to "COME TO CLEVELAND" for the ASHVE ANNUAL MEETING and the HEATING AND VENTILATING EXPOSITION January, 1947

PLANS are well under way according to D. L. Taze, general chairman, Committee on Arrangements, for the 53rd Annual Meeting to be held at the Hotel Statler, Cleveland, Ohio, January 27-30, 1947, and for the 7th International Heating, Ventilating Exposition to be held at Lakeside Hall.

Members are urged not to delay in making their hotel and transportation reservations and their plans to "come to Cleveland" for the Annual Meeting and for the first postwar Heating, Ventilating and Air Conditioning Exposition.

There is a great deal to see in Cleveland, which is celebrating its 150th anniversary in 1946. Since *Moses Cleaveland* first set foot on Cleveland's soil in 1796, it has grown from a single log cabin to a bustling metropolis of a million and a quarter people, a cosmopolitan center of sky scrapers, industrial center, parks and much that is appealing to the visitor. It is the sixth largest city in the United States and the Terminal Tower, one of its skyscrapers, will be remembered as the seventh tallest building in the world. It overlooks Public Square.

The Cleveland Municipal Airport is one of the largest and busiest municipally owned airports in the world covering an area of over 1000 acres. At the western end of the airport is the new government airplane engine research laboratory, largest of its kind in the world, which the members can put down as one of the things to see while in Cleveland.

Coinciding with the dates of the Annual Meeting and Exposition are the dates of the *National Warm Air Heating and Air Conditioning Association*, which will meet at the Hotel Cleveland.

A variety of subjects has been selected by the Meetings Committee for presentation at the technical sessions, at which Pres. Alfred J. Offner will preside. Radiant heating, atmospheric environment in relation to comfort and health, transmission of odors, air flow in duct openings, methods of determining health hazards, and other subjects will be among the topics of discussion. There will also be a panel and radiant heating forum, as well as a joint session with the *National Warm Air Heating and Air Conditioning Association*.

Those who plan to attend the Exposition at Lakeside Hall will learn how much has been gained in the industrial world by the extensive experience gained during the war to bring forth improvements of many kinds and learn of the scientific advances that have been made to meet the economic demands caused by altered manufacturing conditions.

President Offner, chairman of the Advisory Committee of the Exposition, will have Dr. B. M. Woods and Prof. G. L. Tuve, as vice chairmen on the Committee. Others representing the Society serving on the Advisory Committee are: Messrs. H. R. Allonier, L. T. Avery, F. R. Bishop, A. W. Edwards, John Paul Jones, L. P. Saunders, Herman Seelbach, Jr., and J. E. Wilhelm. The leading engineering societies and associations will also be represented.

The leading manufacturers in the country will have on display the largest showing of equipment in the history of the industry, according to an announcement by

Charles F. Roth, manager of the Exposition, and E. K. Stevens, associate manager.

The Northern Ohio Chapter is leaving nothing undone so that your visit to Cleveland will be a memorable one. So plan now to "come to Cleveland" in January.

Aerial View of Downtown Cleveland

COMMITTEE ON ARRANGEMENTS

D. L. Taze, *General Chairman*

Honorary Chairmen

L. T. Avery C. F. Eveleth G. L. Tuve

Vice Chairmen

E. B. Cary F. A. Kitchen
P. D. Gayman L. S. Ries

J. M. Black, *Secretary*

Banquet—John James, *Chairman;* Walter Baggaley, *Vice Chairman;* R. W. Dickson, Jr., D. Gladieux, D. E. Mannen, E. W. Philips, W. B. Watterson, R. A. Wilson.

Entertainment—R. L. Clark, *Chairman;* S. R. Guilbert, L. H. Pogalies, E. J. Sable.

Finance—E. F. Morse, *Chairman;* H. W. Heisterkamp, J. F. Platz, J. A. Schurman, A. L. Vanderhoof.

Inspection—L. G. Powers, *Chairman;* W. M. Rowe, *Vice Chairman;* K. A. Gottschalk, L. H. Jackett, W. P. Miller.

Laboratory Reception—C. M. Humphreys, *Chairman;* R. M. Conner, G. V. Parmelee, J. J. LaSalvia, R. F. Stamberger.

Ladies—R. H. Cutting, *Chairman;* Mrs. R. H. Cutting, Mrs. L. T. Avery, Mrs. P. D. Gayman, Mrs. C. M. Humphreys, Mr. and Mrs. J. P. Jones, Mr. and Mrs. W. R. Rhoton, Mrs. L. S. Ries, Mrs. Cyril Tasker, Mrs. G. L. Tuve.

Publicity—W. R. Moore, *Chairman;* K. T. Davis, W. E. Eynon, R. A. Jack, John Richmond.

Reception—J. E. Wilhelm, *Chairman;* G. P. Nachman, *Vice Chairman;* J. L. Foley, J. L. Frisse, C. L. Grandstaff, H. L. Repp, W. R. Rhoton, L. E. Slawson, H. E. Wetzell, H. K. Jennings (Cincinnati Chapter), R. B. Breneman (Central Ohio Chapter).

Sessions—R. L. Byers, *Chairman;* E. E. Maurer, *Vice Chairman;* P. M. Berry, J. C. Boehm, Jr., L. C. Burkes, H. F. Curtis, T. D. Dravage, J. K. Kinkaid, A. E. Lavelle, H. A. Tolerton.

Transportation—R. E. Sherman, *Chairman;* L. W. Dunbar, P. B. Fleming, J. A. Hall, C. A. McKeeman, C. R. Matthews.

Tentative Program for the 53rd Annual Meeting

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

January 26-30, 1947

Hotel Statler — Cleveland, Ohio

Sunday, January 26

10:00 a.m. Committee Meetings
1:00 p.m. Registration **(Hotel Statler)**
1:30 p.m. Council Meeting
2:00 p.m. Committee Meetings

Monday, January 27

8:30 a.m. Registration **(Hotel Statler)**
9:30 a.m. Opening Session **(Research Laboratory)**
Dedication of Research Laboratory
Reports of Officers
Reports of Committees
Report of Tellers of Election
12:00 noon Luncheon
2:00 p.m. Opening of Exposition **(Lakeside Hall)**
2:30 p.m. Chapter Delegates Meeting
3:00 p.m. Inspection Trips
9:30 p.m. Informal Party and Entertainment

Tuesday, January 28

8:30 a.m. Registration **(Hotel Statler)**
9:30 a.m. Technical Session **(Hotel Statler)**
(3 Technical Papers)
12:00 noon Exposition **(Lakeside Hall)**
2:00 p.m. Panel and Radiant Heating Forum
(2 Technical Papers)
5:30 p.m. Cocktail Hour
6:30 p.m. Past Presidents' Dinner

Wednesday, January 29

8:30 a.m. Registration **(Hotel Statler)**
9:30 a.m. Technical Session **(Hotel Statler)**
(3 Technical Papers)
12:00 noon Exposition **(Lakeside Hall)**
1:30 p.m. Inspection Trips
2:00 p.m. Chapter Delegates Meeting
7:00 p.m. Annual Banquet
Toastmaster
Presentation of Past President's Emblem

Thursday, January 30

9:30 a.m. Technical Session **(Hotel Statler)**
(3 Technical Papers)
Unfinished Business—New Business
Installation of Officers
12:00 noon Exposition **(Lakeside Hall)**
2:30 p.m. Joint Session—*National Warm Air Heating and Air Conditioning Association*

NOMINEES FOR COUNCIL

(Three-Year Term)

M. W. Bishop, Milwaukee, Wis., was born in Corbin, Ky., where he received his early education. He attended Winchester (Ky.) High School and was graduated from Purdue University, Lafayette, Ind., in 1930 with a B.S. degree in electrical engineering.

Following his graduation he became sales engineer for the Amer-

M. W. Bishop
Milwaukee, Wis.

ican Blower Corp., Chicago, covering engineering application and sale of fan, blower and air conditioning equipment. He was transferred to the Milwaukee office in September 1942.

He joined the ASHVE in 1935 as a Junior Member, advancing to Associate in 1939 and finally to full membership in 1942. He served as secretary and vice president of the Illinois Chapter during the years from 1938 to 1943 and as a member of its Board of Governors in 1937. When he was transferred to the Milwaukee office he became affiliated with the Wisconsin Chapter and served as its secretary in 1944 and 1945 and as vice president in 1946.

Mr. Bishop served as a member of the Resolutions Committee in 1941 and 1942, as secretary and chairman of the Nominating Committee representing the Illinois Chapter and as a member of the Constitution and By-Laws Committee. He is now serving as Wisconsin Chapter representative on the Nominating Committee. Mr. Bishop is a member of the Sigma Nu Fraternity.

C. F. Boester, Lafayette, Ind., Housing Research Executive, Research Foundation, Purdue University, was born in Chicago, Ill. and attended public schools in St. Louis.

In 1930 he opened an engineering and contracting business and in 1935 he became air conditioning engineer for City Ice and Fuel Co., St. Louis, where he was in charge of the air conditioning department and engaged in the research and design of ice actuated cooling systems.

From 1937 to 1939 he devoted much of his time to research and development work in air conditioning, and then joined the Marlo Coil Co., St. Louis. On July 1, 1939 he became Director of Hous-

C. F. Boester
Lafayette, Ind.

ing Research at Purdue University.

At Purdue he designed and perfected an air conditioning blanket used in hospitals in connection with fever therapy treatments and he holds many patents in the fields of air conditioning, refrigerating and heat transfer.

In 1943 Mr. Boester was chosen one of the ten outstanding young men of the year by *Future* magazine, official publication of the U. S. Junior Chamber of Commerce.

He joined the Society in 1936 as an Associate member and in 1939 he became a Member. When in St. Louis he served as treasurer, secretary, vice president and president of the St. Louis Chapter, as well as serving as a member of its Board of Governors and on many of its committees. He was a member of the Society's Nominating Committee from 1939-1943 and served a three-year term as a member of the Committee on Research. He served as chairman of its Research Finance Committee and also on many of the Research Technical Advisory Committees.

Mr. Boester has written articles for many of the trade publications. He is now affiliated with the Indiana Chapter of the ASHVE.

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Leo Hungerford, Los Angeles, Calif., was born at Elsie, Mich., where he received his early education. He was graduated from the University of Detroit in 1914 with a C.E. degree in civil engineering.

In 1924 he was appointed chief engineer for Fox West Coast Theaters, Los Angeles, and in 1932 he became general manager for the Pacific Electric and Mechanical Co., Inc. and president of the company in 1933. He

Leo Hungerford
Los Angeles, Calif.

was named manager of the Air Conditioning Department of the Frigidaire Corp., Los Angeles in 1936, and in 1937 he was appointed manager of the Air Conditioning Division of Delco-Frigidaire Corp., Hollywood.

In 1939 he became sales manager for Utility Fan Corp., which is now the Utility Appliance Corp., Los Angeles.

He joined the ASHVE in 1930 and has been active in the Southern Cali-

fornia Chapter since its organization that year. He served as its treasurer for the first four years of the Chapter's existence, as its vice president in 1935 and again in 1943, and as its president in 1936 and again in 1944, as well as serving the Chapter as secretary in 1941 and 1942 and a member of its Board of Governors in 1937 and 1945. Mr. Hungerford was also Chapter representative on the Nominating Committee in 1944 and is serving as chairman of the Chapter Membership Committee in 1946.

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R. F. **Taylor,** Houston, Tex., born in Toronto, Canada, attended government schools, Glen Lyn College and Pietermaritzburg

R. F. Taylor
Houston, Tex.

College in South Africa. He entered the building field with Smith, Rea and Lovitt, architects, Kansas City. This association was interrupted, however, when he enlisted in 1917 in the U. S. Army, trained with the 110th Engineers at Fort Sill, Okla., and served 12 months overseas.

In April 1920 he organized the firm of Taylor and Downes, consulting engineers in Dallas, Tex. and in 1922 he opened his own office which has been responsible for the engineering of 500 buildings of all types, including the 34-story Gulf Building and the 17-story air conditioned Humble Building in Houston, the 30-story tower and other buildings at the University of Texas. Among other projects are the majority of Dallas schools, the Caddo Parish Court House, Shreveport, La., Maricopa County Court House, Phoenix, Ariz., and several air conditioned theaters in Texas.

Mr. Taylor joined the Society in 1915 and is one of the Charter members of the Kansas City Chapter. When the Texas Chapter was first organized in 1937 he served as its president, then when the Chapter was divided into the North Texas and South Texas Chapters he again served as president of the South Texas Chapter in 1939. He also served as a member of its Board of Governors in 1940, 1943 and 1944 and on numerous chapter committees. He is also a member of the 1946 Chapter Relations Committee.

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INTERNATIONAL STANDARDS ASSOCIATION

Dr. P. G. Agnew, chairman of the two-man American delegation to the forthcoming meeting in London of representatives of 20 countries engaged in setting up the new *International Standards Association* to coordinate standardization work throughout the world, sailed aboard the Scythia for Europe on October 8th.

Dr. Agnew, vice president and secretary of the *American Standards Association*, met the other American delegate in London, E. C. Crittenden, associate director, National Bureau of Standards, Washington, D. C., and ex-officio chairman of the *ASA* Standards Council, where they attended the meetings from October 14-26, at the Institution of Civil Engineers, Westminster, London.

In addition to the United States the following countries were represented: Australia, Belgium, Brazil, Canada, Chile, China, Czechoslovakia, Denmark, France, Great Britain, India, Mexico, Netherlands, New Zealand, Norway, Poland, South Africa, Sweden, and the U.S.R.R.

Representatives from nine of these countries met in Paris in July at which preliminary organization steps were taken. Delegates to this meeting represented an emergency war time body.

Due to the great demand for an international organization for the purpose of developing standards, numerous projects already have been referred to the new group for action, which will be taken as soon as the formal organization is completed. Among those suggested for consideration by the *American Standards Association* are a number in the field of standards for motion pictures, textile test methods, chemical methods, and a standard definition for the term *rayon*.

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I. B. HELBURN IN NEW POST

The appointment of I. B. Helburn, Cincinnati, Ohio, as a new representative for the American Air Filter Co., Inc., Louisville, Ky., has just been announced by the company. Mr. Helburn's territory will include Cincinnati and Southern Ohio, and he will operate under the firm name of Helburn Engineering with offices at

I. B. Helburn

406 Elm St., Cincinnati. He has been connected with the filter firm for the last 22 years, serving in various capacities both in the main office and plant in Louisville and Cincinnati.

He was born at Stanford, Ky., and was graduated from the University of Kentucky with a B.M.E. degree. He specialized in thermodynamics, laboratory research, testing of heat power plant equipment, and made studies on methods of dust determination. During the First World War he served as a member of the A.E.F.

He joined the ASHVE in 1927 and has been active in Cincinnati Chapter activities, serving as vice president and president of the Chapter in 1936 and 1937. He was instrumental in bringing two of the Society's Annual Meetings to Cincinnati, the 39th and the 49th in 1933 and 1943. Mr. Helburn is also a member of the *American Foundrymen's Association* and a member of Tau Beta Pi, national scholastic honorary fraternity.

URDAHL & EVERETTS FORM PARTNERSHIP

Capt. Thomas H. Urdahl, USNR, and Comdr. John Everetts, Jr., USNR, members of the ASHVE, recently released to inactive duty by the Navy, have joined forces as consulting engineers, specializing in problems associated with air conditioning, industrial drying and dehumidification.

Offices have been established at 212 Mission St., San Francisco 5, Calif., under the direction of Mr. Everetts, and a temporary office at 726 Jackson Place, N.W., Washington 6, D. C., under direction of Mr. Urdahl.

Mr. Urdahl, in private practice of engineering since 1926, was commissioned a Lieutenant Commander in the Naval Reserve in November 1939, was on active duty in the Bureau of Ships from February 1941 until August 1946, and served as Head of the Air Conditioning Section, with responsibility of air conditioning, ventilating and heating of all vessels in the United States fleet.

Mr. Everetts was commissioned a Lieutenant in the Naval Reserve in July 1942 and was assigned to duty in the Bureau of Ships, where he served as west coast representative of the Air Conditioning Section, making his headquarters in San Francisco, handling all technical problems, as well as the procurement and distribution of equipment for heating, ventilating and air conditioning of Naval vessels at all west coast activities.

Responsibility for the development of dehumidification methods and equipment and their application to preservation of the Inactive Fleet also came under the Air Conditioning Section as the duty of these officers and Comdr. E. R. Queer, who has also recently returned to inactive duty in his former position as research professor at the Engineering Experiment Station, Pennsylvania State College.

Mr. Urdahl, since joining the Society in 1930, served as a member of the Society's Council for two consecutive terms from 1940 through 1945, as well as on many Research Technical Advisory Committees. He is at present vice chairman of the Committee on Research and is just completing a third term on this committee. He is an active member of the Washington D. C. Chapter, serving as its president in 1939, vice president from 1934-36, and as a member of its Board of Governors for several years. He is also a member of the *Society of Naval Architects and Marine Engineers* and other technical societies, and is a registered professional engineer in the states of Pennsylvania, New York, Florida and Maryland.

Mr. Everetts, a member of the ASHVE since 1929, has been very active as a participating member of many of the Research Technical Advisory Committees. He is chairman of the TAC on Sorbents and a member of the TAC on Weather Design Conditions. He is also a member of *The American Society of Refrigerating Engineers.*

A. P. SHANKLIN PROMOTED

Appointment of Arthur P. Shanklin, Syracuse, N. Y., as vice president and general sales manager of Carrier Corporation has been announced by E. T. Murphy, senior vice president.

Effective November 1, 1946, Mr. Shanklin will be in charge of all of

A. P. Shanklin

Carrier's domestic sales activities. A vice president of Carrier Corp. since 1941, Mr. Shanklin has been associated with the company since his graduation from the University of Kentucky in 1922. During this period he has served in many sales and executive capacities and at present is vice president in charge of dealer sales.

NEW EDITOR ON *REFRIGERATING ENGINEERING*

The *ASRE* has announced the appointment of Fred C. Kelly, Jr., New York, as editor of *Refrigerating Engineering,* their monthly journal.

Mr. Kelly, born in Cleveland, Ohio, was graduated from Purdue University where he specialized in mechanical engineering. Following his graduation he worked as a reporter on the Akron Times Press and after several years on newspaper work he became associate editor of *Machine Design.* He was also associated for a time as technical editorial writer with McCann-Erickson Advertising Agency, and later with the G. M. Basford Agency, both in New York City. Prior to assuming his new position he was employed by the firm of Johnson-Cushing-Nevell where he was engaged in writing and editing Ordnance Manuals for the Army and Navy.

CARRIER-MANDELL ORGANIZED

Carrier-Mandell, Inc., 177 State St., Boston, Mass., is the name of the new corporation just formed as announced by Messrs. Earl G. Carrier, Thomas P. Mandell and James P. Licandro. The new firm will conduct the sales and servicing of equipment for air conditioning, refrigeration and ventilation. The company's sheet metal shop is located at 307-311 Atlantic Ave., Boston.

Mr. Carrier, a member of the Society's Council and past president of the Massachusetts Chapter of the Society, has specialized in designing and supervising engineering work, with many years experience in air conditioning, heating and refrigeration in the industrial, domestic and commercial fields. He was born in Buffalo, is a graduate of the University of Wisconsin and holds a B.S. degree in mechanical engineering. He joined the staff of Carrier Corp. in 1929 as estimator and sales engineer. He became a Junior Member of the ASHVE in 1929 and was advanced to full membership in 1936.

Mr. Mandell, born in Beverly, Mass., attended St. Mark's School, Southboro, Mass., Harvard University and took special courses at Massachusetts Institute of Technology. He became a member of the ASHVE in 1937.

Mr. Licandro, born in New York

City, attended the DeWitt Clinton High School and was graduated from Polytechnic Institute of Brooklyn with a B.E.E. degree in electrical engineering in 1935. He joined the Society as a Junior Member in 1938 and was advanced to Member grade in 1943.

IN NEW POSTS

Arthur G. Stout, a member of the Illinois Chapter of the ASHVE, has opened his own office as consultant under the name of Arthur G. Stout and Associates, at 400 W. Madison St., Chicago 6, Ill., specializing in air conditioning and refrigeration work. Mr. Stout has had a wide experience in this field and was formerly assistant chief mechanical engineer for Holabird and Root, Chicago.

Walter A. Stahl, also a prominent member of the Illinois Chapter of the Society, has announced that he has severed his connection with Montgomery Ward and Co., and is now superintendent of the Merchandise Mart, 222 N. Bank Drive, Chicago 54, Ill.

Both Mr. Stout and Mr. Stahl served on the Illinois Chapter's meetings and publication committees during 1945, and have been members of the ASHVE for several years.

PROMOTIONS ANNOUNCED

C. B. Sweatt, executive vice president, Minneapolis - Honeywell Regulator Co., Minneapolis, Minn., has announced several supervisory changes including promotions of field and home office personnel. Five of these concern members of the ASHVE.

J. S. Locke, member of the Illinois Chapter who joined the Society in 1939, has been Chicago regional sales manager of the company's Air Conditioning Controls Division. His new assignment is sales manager of the division with headquarters in Minneapolis. Mr. Locke joined Minneapolis-Honeywell in 1932 in the New York service department. In 1934 he was transferred to the company's Modutrol Division in Minneapolis and a year later he was sent to Chicago in the same capacity. During the war years, Mr. Locke supervised sales, engineering, installation and service of the company's automatic control systems for aircraft engine test cells and in March 1944 was elevated to Chicago regional manager of the Air Conditioning Controls Division, which position he held until his recent promotion.

G. D. Guler, who joined the ASHVE in 1937, has been sales manager of the Air Conditioning Controls Division in Minneapolis and is now located in Atlanta as regional manager in that territory. Mr. Guler joined the staff of Minneapolis-Honeywell in 1929 and until 1940 served in the Air Conditioning Controls Division in the company's Baltimore and Philadelphia branches. He succeeds A. H. Koch who has been made Philadelphia branch manager.

Mr. Koch, a member of the Society since 1938, started with Honeywell's Brown Instrument Division in 1929 and later served in Chicago, Minneapolis, Honolulu and Cleveland in the sales department of that division. In 1938 he was made Atlanta branch manager and in 1942 was promoted to regional manager with headquarters in the same city.

Succeeding Mr. Locke in Chicago is J. F. Cummiskey, a member of the Illinois Chapter of the ASHVE. Joining Honeywell in 1937, where he worked in the factory inspection department, Mr. Cummiskey was later transferred to air conditioning controls sales where he served in the company's Twin City and Milwaukee branch offices until 1942, when he was transferred to Chicago.

L. C. Johnson has been promoted to branch manager in Milwaukee, replacing Harold K. Pride, also a member of the Society, who has resigned to accept a position with a Honeywell distributor.

J. C. Dorsey, who has been acting branch manager in Philadelphia, has been placed in charge of manufacturers' business in Philadelphia and will supervise all such activity in the southern part of the company's eastern sales zone.

T. S. Carley, Minneapolis, who joined the ASHVE in 1945, has been promoted to sales manager of the Wholesale Division and, in addition, will continue as sales manager of the Stoker Controls Division. Mr. Carley started in the production department of the company in 1935 and in 1939 was transferred to wholesale sales in the Minneapolis office. From 1940 to 1944 he held a similar position in the San Francisco office, returning to Minneapolis at that time as assistant sales promotion manager. In 1945 he was placed in charge of stoker controls sales, which position he held until his current advancement.

J. S. Locke

G. D. Guler

A. H. Koch

T. S. Carley

NORMAN HOLLISTER DIES AT 57

Word has been received of the death of Norman A. Hollister, supervising air conditioning engineer in the Architect's office at the Capitol, Washington, D. C., who suffered a stroke on September 30th. He never regained consciousness and died the following day, October 1, at Arlington Hospital, Arlington, Va. Mr. Hollister's passing will come as a shock to his friends and associates in the heating and ventilating profession. Although he had suffered from high blood pressure for some time, his health was apparently much improved before his death.

He was born at Melbourne, Australia on February 13, 1889, while his parents, who were U. S. citizens, were traveling in Australia. He was educated in Jamestown, N. Y. and graduated from Carnegie Institute of Technology with a B.S. degree in 1914. Soon after graduation he entered the employ of the American Blower Corp., working in the Detroit, Boston and New York offices as research, drafting and general fan sales engineer. He left to become chief engineer for the American By-Products Machinery Co., but returned to the New York office of American Blower in January, 1920, where his work covered general and miscellaneous fan engineering, industrial field work, air conditioning, drying and paper mills.

In February, 1925 he transferred to Drying Systems, Inc., New York, as sales engineer and Eastern manager. He prepared many of the drawings, supervised installations, and was in charge of testing and demonstrations. After this office closed he handled engineering contracts in his own name, and in 1933 he became sales supervisor for the Mills Novelty Co., New York, N. Y., where he interviewed, hired, trained and supervised high type specialty salesmen working on commission basis.

In 1934 he was the New York manager of The Trane Co. In 1942 and 1943 he was associated with Air and Refrigeration Corp., in their Detroit office. In 1943 he went to Washington as supervising air conditioning engineer in the Architect's office at the Capitol, which position he held at the time of his passing.

Mr. Hollister joined the ASHVE in 1933 and served on several Society committees and as chairman of the special committee on Safety Regulations for heating, ventilating and air conditioning systems. He was the ASHVE representative on the *NFPA* Blower Systems Committee.

The Officers and Council of the Society extend their sincerest sympathy to his widow, Mrs. Thyra A. Hollister, to his daughter, Sgt. Betty Jane Hollister, and to his son, Paul M. Hollister, New York. Funeral services and interment were in Washington, D. C.

SUMMARY OF LOCAL CHAPTER MEETINGS*

CENTRAL NEW YORK—September 18. Subject: Society Research—Present Program and Future Possibilities. Speaker: Cyril Tasker, director of research, ASHVE Research Laboratory, Cleveland, Ohio. Those entering into the discussion which followed Mr. Tasker's talk were Messrs. C. M. Ashley, W. H. Carrier of Carrier Corp., Syracuse, N. Y., and R. L. Manier, Central New York Power and Light Co. H. G. Strong presented a tentative schedule of the dates and subjects to be discussed at subsequent meetings of the Chapter. Attendance, 25. Attendance ratio, 0.23.

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CENTRAL OHIO—September 16. Subject: History and Application of Axial Flow Fans to Domestic and Industrial Equipment. Speaker: Dr. T. H. Troller, La-Del Div., Joy Mfg. Co., New Philadelphia, Ohio. Dr. Troller stated that the development of the axial fan had been closely connected with the aircraft industry and pointed out that the development of axial fans was greatly accelerated by the need of such fans in wind tunnels and in turbo jet engines. He divided the history of the fans into four groups. The first two, the propeller and the vane axial, the two most interesting to the heating and ventilating engineers. The third group, he explained, is similar to the vane axial fan except that it has very small blades and more nearly approaches conventional turbine design. The fourth class, Dr. Troller stated is in very early development stages, but is similar to the third except that blade speeds are operated in the supersonic speed range above 1140 fps. He further stated that such fans have demonstrated their ability to develop pressure ratios of 2.0 to 2.4 in a single stage. He illustrated his talk with slides. President Allonier reported on the Semi-Annual Meeting of the Society in Montreal. Attendance 44. Attendance ratio 0.49.

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CONNECTICUT—September 26. An interesting inspection trip through the U. S. Submarine Base, New London, Conn., with dinner at Skippers Dock, Noank, Conn., opened the fall season. Pres. P. D. Bemis presided and introduced Comdr. R. H. Barnes, Comdr. J. C. Tate, Comdr. G. W. Van Atta and Ensign R. L. Sulser. C. L. L'Hommedieu reported on the Semi-

*Note. The attendance ratios shown represent the membership attendance divided by the chapter membership. These ratios will be useful as a partial indication of interest shown by local chapter members in various types of subjects programmed by the various chapters and may be useful in deciding on subjects for chapter meetings.

Annual Meeting in Montreal. A. J. Lawless, chairman of the meetings committee announced the schedule of meetings for the season. President Bemis announced the election of the nominating committee as follows: L. A. Teasdale, chairman; L. O. R. Clark, H. J. Blakeley, E. R. Clement, Sr., and W. A. Johnson. Attendance 63. Attendance ratio 0.4.

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DELTA—September 10. Subject: Problems of the Refrigeration Service Man. Speaker: Forrest Clupper, Industrial Refrigeration Service. In the discussion the speaker was asked to point out some of the things that the service man might want the engineers to do, in order to help cooperate with the service man in general. Mr. Clupper replied that the engineers could be very helpful if they would furnish wiring diagrams for the installation, specify the suction pressure at which the job was designed to operate, and give the speed of the fans, etc. This meeting was held out of doors at the home of R. K. Rothrock in New Orleans and the members and guests enjoyed supper after the discussion. During supper they were entertained by the stories of the Mayor of *Bayou Pom Pom*. Attendance 22. Attendance ratio 0.44.

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GOLDEN GATE—September 4. Subject: Illumination as it Affects Air Conditioning. Speaker: R. E. Lagerstrom, Illumination Engineer, General Electric Lamp Works. Following the talk, Mr. Lagerstrom very ably answered numerous questions from the floor. President Gayner introduced the various committee chairmen. R. B. Holland suggested that members should offer any constructive criticism with regard to chapter meetings. President Gayner elaborated on this suggestion and informed the members that the Chapter Officers would appreciate constructive criticism at any time. Attendance 37. Attendance ratio 0.73.

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INDIANA—September 27. Subject: Fire Causes, Fire Fighting and Fire Prevention. Speaker: Charles Gregory, chief, Indianapolis Fire Department. Minutes of the June meeting and of the August Board of Governors meeting were read and approved. I. W. Cotton reported for the membership committee and W. R. Fenstermaker reported for the meetings and program committees and promised some surprisingly good programs for the immediate future. G. B. Supple reported on the Semi-Annual Meeting of the Society. A vote was taken as to the possible attendance if a Society Meeting were held in Los Angeles or Des Moines. Attendance 30.

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KANSAS CITY—September 30. Subject: Technology Tomorrow. Speaker: Dr. Baldwin M. Woods, first vice president of ASHVE and director of University Extension, University of California, Berkeley, Calif. Dr. Woods' talk was enthusiastically received. In a clear and interesting manner he discussed the basic technological developments that have grown up in this country and presented some of the developments which we may expect in the future. The Kansas City Chapter members expressed their opinion that they were very fortunate to have Dr. Woods as speaker and expressed their gratitude to the Society for making his services available to them. Attendance 57.

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MEMPHIS—August 19. Subject: Electric Welding. Speakers: John E. Durstine and R. R. Aschinger, Lincoln Electric Co. Their talk on electric welding featured a polariscope. President Hoshall asked W. E. Thorpe for a report on the interpretation of the By-Laws as to the fiscal year dates which he will give at the next meeting. Attendance 21. Attendance ratio 0.60.

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MONTREAL—October 7. The opening meeting of the fall season was in the form of a golf tournament on the Mount Royal golf course with an attendance of 44 members and guests. The ASHVE cup was awarded to Jack Wright who had a low net of 72. Other chapter winners included Messrs. W. G. Hole, L. A. Hood, A. F. Lamontagne, S. G. MacDermot, E. H. Terrance, James Wilson, and T. H. Worthington. The golf committees consisted of Mr. Lamontagne, chairman, with Messrs. Cosgrove, Salter, Worthington and Wright assisting. A. B. Madden acted as host for the Chapter and it was generally agreed that the tournament and dinner was a great success and a good omen for the start of the fall and winter sessions.

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NEW YORK—The Building Trades Employer's Club, 2 Park Ave., New York 16, N. Y., has been selected as the most convenient meeting place for the New York Chapter for the 1946-47 season. Meetings will be held on the third Monday of each month October through May. Following a social period beginning at 5:45 p.m., dinner will be served at 6:15 p.m. and a technical program will follow at 7:15. Pres. W. A. Sherbrooke has appointed Peter B. Gordon chairman of the Program Committee.

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NORTH TEXAS—September 16. Subject: Kathabar Applications Ranging from Residential Units to Large Industrial Installations. Speaker: F. M. Johnson, Surface Combustion Corp. Mr. Johnson supplemented his talk with slides of the lithium chloride method of humidity control. A long period of discussion followed. After reports of the various committee chairmen, Vice President Gardner outlined the Annual Meeting of the Society to be held in Cleveland in January and urged members to try to combine their visits to their fac-

tories so as to coincide with this meeting. Attendance 75.

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NORTHERN OHIO—September 26. A golf party and clambake was held at Columbia Hills Country Club with E. W. Philips as chairman of the entertainment committee. The program was enjoyed by 26 golfers who were later joined by 28 others for dinner. A silver trophy plate was awarded to W. P. Miller for low gross score.

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ST. LOUIS—September 10. Subject: The Present Day Fuel Oils, Their Production and Use in Burners. Speaker: Louis B. Sullivan, combustion engineer, Shell Oil Co., Inc. He explained the change in processing of oil, resulting in more so-called *cat* fuels, and that due to the peculiarities of these new fuels, the burning equipment would have to be changed to efficiently burn this new type of fuel without smoke. Mr. Sullivan's talk was well received and President Simons thanked him on behalf of the Chapter. H. C. Sharp reported on the plans of the membership committee for the coming season. Mr. Sharp will act as membership coordinator and a different chairman has been appointed for each month. These chairmen and Mr. Sharp will comprise the membership committee and will appreciate the cooperation of the entire membership in their drive to increase the St. Louis Chapter membership. Attendance 36. Attendance ratio 0.44.

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SOUTH TEXAS—September 13. Subject: Centrifugal Compressors. Speaker: Paul Roll. An interesting discussion followed Mr. Roll's talk. A. J. Natkin was appointed chairman of the attendance committee. Plans for the October meeting were then discussed and it was arranged to have a group of South Texas members meet President and Mrs. Offner and Dr. Woods at the airport upon arrival. Attendance 64.

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SOUTHERN CALIFORNIA—September 11. Subject: Technology Tomorrow. Speaker: Dr. Baldwin M. Woods, first vice president of the Society and director of the University Extension, University of California, Berkeley, Calif. Dr. Woods pointed out that technology of tomorrow is the process of analyzing what present inventions and ideas would be industries for the future. He illustrated how in 1920 the following analysis led to major industries: telephone, automobile, airplane, motion pictures, rayon and radio. The 1920 prediction, Dr. Woods stated, proved 78 per cent correct and he further pointed out that in 1936 an attempt was made to forecast the future employment in industries making the following: plastics, general adoption of air conditioning, steep flight airplanes, cotton picker, cellulose products (nylon), trailer homes, prefabricated homes, and synthetic rubber. Of this 1936 forecast Dr. Woods pointed out that almost all have been the foundation for a major industry. He used these as illustrations to show that it is possible to predict industry-wise invention that will be successful in the future. He concluded his remarks by giving four trends of applying the technology of engineering to the betterment of living for the future.

A motion was made and passed for the Chapter to acknowledge by letter the deaths of Harrold English, English and Lauer, and of Edwin P. Norberg, Los Angeles Board of Education. Art Theobald and R. A. Lowe were unanimously elected as delegate and alternate for the Society's Annual Meeting in January. Attendance 63. Attendance ratio 1.09.

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UTAH—October 4. Subjects: War Surpluses; Restriction on Construction and Building Material. Speakers: J. H. Willis, regional director, War Assets Administration; W. P. Henock, assistant manager, local office of Civilian Production Administration. Mr. Willis briefly outlined the background of the WAA and stated the need for such an organization was found necessary based on the experiences encountered in disposing of surplus materials following the first world war. He explained that the WAA disposes of surplus materials on a priority basis with veterans given top priority, then the RFC acting for small business, state and local governments, and non-profit and tax exempt institutions in that order. He stated that up to the present time only about 25 per cent of the available material has been sold.

Mr. Henock stated that the purpose of the CPA is to allocate materials for civilian construction on as equitable a basis as possible. In addition to setting aside the majority of available materials for veterans housing the speaker pointed out that allowances are made for business and residential repairs. An interesting discussion followed with numerous questions asked. Attendance 27. Attendance ratio 0.55.

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WISCONSIN—September 16. Subject: The Case for Unit Heaters in Commercial and Industrial Heating. Speaker: Frank J. Tyler, Herman Nelson Corp., Moline, Ill. C. H. Amundson, chairman of the membership committee, announced that the total Chapter membership was 88. Mr. Tyler's talk brought out the advantages of unit heaters in commercial and industrial heating, which included the flexibility of application and operation, simplicity of control, ease of installation, and economy. Mr. Tyler agreed that each of the methods of heating had its place. Mr. Tyler then introduced C. A. Pickett of the Chicago office of the corporation who continued the discussion, describing various types of unit heaters and ventilators and cited a few applications of these units.

J. R. Vernon, speaking for the program committee chairman, announced that C. M. Burnam, Jr., editor, Heating, Piping & Air Conditioning, Chicago, would provide a talk for the October meeting, prepared especially for the Wisconsin Chapter on planning practical value in an engineering magazine. Attendance 44. Attendance ratio 0.5.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 97 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by November 30, 1946, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

ALBRIGHT, JOSEPH C., Cons. Engr., Davison Chemical Corp. PROPOSERS: Cyril Tasker, T. H. Urdahl. SECONDERS: C. M. Humphreys, A. E. deSomma.

ALSCHULER, JOHN H., Draftsman, G. M. Simonson. PROPOSERS: G. M. Simonson, N. A. Melnick. SECONDERS: J. F. Kooistra, D. I. Murphy.

BARD, WILLIAM S., Instructor, Chicago Technical College. PROPOSERS: C. M. Burnam, Jr., J. F. Cummiskey. SECONDERS: C. E. Price, M. J. Bamond

BAZZONI, JOSEPH P., Mech. Engr., John Dolio Engineers. PROPOSERS: E. G. Roessle*, Al Goulding*. SECONDERS: John Dolio*, Chris Gunther*. (*Advancement*)

BEACH, MILTON W., Sales Engr., M. W. Beach Sales & Engineering. PROPOSERS: H. K. Jennings, R. E. Peck. SECONDERS: E. J. Richard, E. W. McNamee.

BOLTON, OTIS J., Student, Texas A & M College. PROPOSERS: J. S. Hopper, W. E. Long. SECONDERS: Carl Files*, E. S. Holdredge*.

BROWN, LEROY, JR., Student, Texas A & M College. PROPOSERS: J. S. Hopper, W. E. Long. SECONDERS: Carl Files*, E. S. Holdredge*.

BUCKLEY, MALCOLM L., Htg. & Power Engr., Phillips Getschow Co. PROPOSERS: R. M. Getschow, A. O. May. SECONDERS: J. J. Hayes, C. M. Burnam, Jr. (*Reinstatement & Advancement.*)

BURKHARDT, CHARLES H., Dept. Head, YMCA Technical Institute. PROPOSERS: H. J. Ryan, J. W. McGuire. SECONDERS: G. J. Sweeney, L. B. Miller.

BURTON, JOHN E., Student, Texas A. & M. College. PROPOSERS: J. S. Hopper, W. E. Long. SECONDERS: Carl Files*, E. S. Holdredge*.

CALLIS, DANIEL K., Pipe Shop Foreman, Inland Steel Co. PROPOSERS: A. V. Barnes*, R. A. Miller*. SECONDERS: H. C. Johnson*, J. J. Borkert*.

CAPRON, RODY G., Appl. Engr., Enterprise Engine & Foundry Co. PROPOSERS: J. F. McIndoe, R. B. Holland. SECONDERS: R. C. Cushing, C. L. Peterson.

CARSON, JAMES H., Owner, Carson Pacific Boiler Service. PROPOSERS: L. C. Medcalf, Sidney Samuels. SECONDERS: J. W. Kingsbury*, H. L. Hosking*.

CARTER, DONALD G., Student, Washington University. PROPOSERS: J. H. Carter, E. E. Carlson. SECONDERS: B. C. Simons, G. W. F. Myers.

CLIFFORD, LESLIE F., Asst. Chief Mech. Engr., Skidmore, Owings & Merrill. PROPOSERS: J. J. Philippi, O. G. Ward. SECONDERS: M. F. Mattingly, M. J. Bamond.

COMPTON, BASIL C., Sales Engr., D. C. Air Conditioning Co. PROPOSERS: M. F. Carlock, E. E. Carlson. SECONDERS: H. C. Sharp, J. D. Coad.

COOK, HAROLD V., Asst. Mgr., L. Cook Plumbing & Heating Co. PROPOSERS: F. C. Allen, E. J. McEahern. SECONDERS: J. F. Mohan, F. L. Adams.

COOPER, W. B., Chief Engr., Advanced Refrigeration Co. PROPOSERS: H. K. Jennings, R. W. Sigmund. SECONDERS: A. W. Edwards, E. W. Seibert. (*Advancement*).

CORNWALL, CHARLES C., Engr., The Bahnson Co. PROPOSERS: Arvin Page, Frederick Boxall. SECONDERS: M. G. Saunders, Jr., DeParx Stimson (*Advancement*).

CURRIE, RAYMOND C., Engr. Pacific Heating & Sheet Metal Co. PROPOSERS: H. V. Hickman, D. F. Owens. SECONDERS: R. C. Cushing, D. L. Williams.

DANIEL, JAMES M., Student, Texas A & M College. PROPOSERS: J. S. Hopper, W. E. Long. SECONDERS: Carl Files*, E. S. Holdredge*.

DAVIS, CLYDE W., Owner, C. W. Davis Plumbing & Heating. PROPOSERS: L. O. Johnson, J. A. Shanklin. SECONDERS: H. M. Kuler*, J. A. Bailey.*

DE BRUYN, LEO F., Service & Installation Mgr., Minneapolis-Honeywell Regulator Co. PROPOSERS: F. C. Purcell, D. J. Peterson. SECONDERS: W. H. Old, K. L. Wilson.

DE FLON, JAMES G., Dist. Engr., The Fluor Corp. PROPOSERS: Art Theobald, A. G. Orear. SECONDERS: H. H. Douglas, Leo Hungerford. (*Advancement*).

DWYER, WILLIAM H., JR., Sales Engr., Whittington Pump & Engineering Co. PROPOSERS: W. P. Whittington, G. C. Joslin. SECONDERS: W. C. Bevington, W. H. Dwyer, Sr.

DYE, O. E. F., Asst. Chief Mech. Engr., Commonwealth Department of Works. PROPOSERS: T. A. Roseby, Geoffrey Davey. SECONDERS: S. R. Bell, A. E. Atherton.

EDDY, HARVEY W., Htg. & Vent. Engr., California-Fresno Supply Co. PROPOSERS: D. L. Williams, O. D. Paulson. SECONDERS: C. L. Peterson, R. C. Cushing.

ELMS, WILLIAM P., Htg. Engr., General Steel Wares, Ltd. PROPOSERS: C. W. Gordon, H. R. Roth. SECONDERS: D. O. Price, A. G. Baird.

ENGONOPULOS, BASIL G., Student, University of Idaho. PROPOSERS: H. F. Gauss*, J. J. Hugo*. SECONDERS: J. C. Bliss*, J. T. Askitoglon*.

FALK, JEROME, Mech. Engr., Consolidated Conditioning Corp. PROPOSERS: L. J. Wachs, B. B. Howes. SECONDERS: J. D. W. Robertson, J. R. Duncan*.

FARR, ARTHUR H., Chief Engr., Allied Refrigeration Corp. PROPOSERS: J. C. Boehm, Jr., J. L. Frisse. SECONDERS: R. L. Byers, R. A. Urban

FELDMAN, NATHAN R., Sr. Engr., Philco Corp. PROPOSERS: M. C. Terry, H. K. Steinfeld*. SECONDERS: J. J. Judd*, W. H. Mullin*.

FIELD, EUGENE, JR., Student, Texas A & M College. PROPOSERS: W. E. Long, J. S. Hopper. SECONDERS: Carl Files*, C. W. Crawford*.

FINE, ARTHUR T., Owner, Hartford Oil Heating Co. PROPOSERS: J. R. Howard, G. F. Murray. SECONDERS: F. L. Hausser, R. M. Ripley.

FLAGG, WILLIAM J., Chief Engr., Ohlssons Cape Breweries, Ltd. PROPOSERS: T. H. Gouldbourne, F. G. Seymour. SECONDERS: H. Young, C. R. Johnston.

FOULGER, SID W., Flint Distributing Co. PROPOSERS: H. G. Richardson, J. T. Young, Jr. SECONDERS: E. J. Watts, G. C. Campbell.

GILMORE, C. F., Student, Texas A & M College. PROPOSERS: J. S. Hopper, W. E. Long. SECONDERS: Carl Files*, E. S. Holdredge*.

HAUER, B. T., Owner, Hauer Power Equipment Co. PROPOSERS: W. J. Killian, K. B. Little. SECONDERS: G. P. Mursinna, W. R. Fenstermaker.

HAYES, GRANT J, Engr., Hayes Brothers, Inc. PROPOSERS: W. F. Freije, G. O. Jackson. SECONDERS: J. G. Hayes, C. N. Warren.

HEINISCH, JOHN E., Owner, Air Conduit Co. PROPOSERS: D. M. Mills, B. P. Fisher. SECONDERS: C. L. Boehler, A. J. Natkin.

HENTON, L. W. J., Htg. & Vent. Supt., Gaumont British Picture Corp., Ltd. PROPOSERS: Walter Harding, Doctor Carter. SECONDERS: Thomas Chester, H. W. Lipscombe.

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HILL, JAMES H., Student, Texas A & M College. PROPOSERS: J. S. Hopper, W. E. Long. SECONDERS: Carl Files*, E. S. Holdredge*.

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HUNTER, RICHARD K., Mfrs. Agent, Hunter-Hoffman Co. PROPOSERS: W. D. Graham, G. B. Rottman. SECONDERS: Arvin Page, W. M. Wallace II.

JAMES, JACK K., Student, Texas A & M College. PROPOSERS: J. S. Hopper, W. E. Long. SECONDERS: Carl Files*, E. S. Holdredge*.

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JENNINGS, ROBERT B., Mgr., Columbus Dist., The Trane Co. PROPOSERS: R. B. Jackson, T. R. Walker. SECONDERS: T. H. Bell, H. R. Allonier.

JOHNSON, FRED R., Owner, Johnson Heating Supply Co. PROPOSERS: E. R. Lokey, A. E. Finlay. SECONDERS: A. E. Kendrick, T. H. McClung.

JONES, ORAN D., Student, Texas A & M College. PROPOSERS: J. S. Hopper, W. E. Long. SECONDERS: Carl Files*, E. S. Holdredge*.

JUER, FREDERICK, Sales Engr., Minneapolis-Honeywell Regulator Co. PROPOSERS: E. W. McNamee, G. R. Chadwick, SECONDERS: A. Edwards, J. Schweiger.

KAY, HERBERT M., Student, Texas A & M College. PROPOSERS: J. S. Hopper, W. E. Long. SECONDERS: Carl Files*, E. S. Holdredge*.

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LEE, RALPH H., Sales Engr., Minneapolis-Honeywell Regulator Co. PROPOSERS: J. T. Young, Jr., E. J. Watts. SECONDERS: E. V. Gritton, E. L Richardson

LIPPERT, WAYNE M., Student, Texas A & M College. PROPOSERS: J. S. Hopper, W. E. Long. SECONDERS: Carl Files*, E. S. Holdredge*.

LYNCH, JOHN T., Head, Air Cond. Dept., The David Ranken Jr. School of Mechanical Trades. PROPOSERS: G. B. Rodenheiser, George Myers. SECONDERS: B. L. Evans, C. E. Hartwein.

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MCGARY, ROBERT O., Sales Engr., Buensod Stacey, Inc. PROPOSERS: Karl Selden, Jr., A. C. Buensod. SECONDERS: J. D. Shepard, H. L. Janet.

MCKENZIE, HAROLD W., Estimator, Thompson Sheet Metal Works. PROPOSERS: T. E. Taylor, T. H. McClung. SECONDERS: R. C. Chewning, J. H. Bonebrake.

MULLINIX, ROBERT M., Student, Texas A & M College. PROPOSERS: J. S. Hopper, W. E. Long. SECONDERS: Carl Files*, E. S. Holdredge*.

NORRINGTON, WALTER L., Mech. Engr., William K. Karsunky. PROPOSERS: W. K. Karsunky, J. J. Nolan, Jr. SECONDERS: E. K. Stevens, C. F. Roth. *(Advancement).*

OFFNER, THEODORE, Mgr., Air Cond. Dept., Gulf Engineering Co. Inc. PROPOSERS: F. G. Burns, G. E. May. SECONDERS: C. B. Gamble, H. L. Salaun.

ORR, JAMES D., Supt., Orr-Guiton Co. PROPOSERS: E. A. Allcut, F. G. Ewens. SECONDERS: R. P. Allsop, A. M. Kennedy.

PEISER, MAURICE B., Sales Engr., Natkin & Co. PROPOSERS: E. P. Harder, E. E. Carlson. SECONDERS: George Myers, B. L. Evans *(Advancement).*

PHILLIPS, RALPH W., Engr., Shelby Skipwith, Inc. PROPOSERS: A. W. Shelby, A. T. Bevil. SECONDERS: E. E. Scott, T. J. O'Brien.

PRICE, PHILLIP M., Student, Texas A & M College. PROPOSERS: J. S. Hopper, W. E. Long. SECONDERS: Carl Files*, E. S. Holdredge*.

RAMSEY, RALPH, Mgr., Coil Dept., Trane Co. of Canada, Ltd. PROPOSERS: V. J. Jenkinson, H. R. Roth. SECONDERS: G. E. Cole, J. L. Neilans

REED, JOHN C., Mgr., Research & Prod. Dvlpt., American Radiator & Standard Sanitary Corp. PROPOSERS: B. Goerg, T. W. McMahon. SECONDERS: R. E. Daly, G. M. Maier.

RYAN, KEY W., Student, Texas A & M College. PROPOSERS: J. S. Hopper, W. E. Long. SECONDERS: Carl Files*, E. S. Holdredge*.

SCHUCHART, OSCAR W., Student, Texas A & M College. PROPOSERS: J. S. Hopper, W. E. Long. SECONDERS: Carl Files*, E. S. Holdredge*.

SCHUETT, DONALD F., Mgr., Air Cond. Dept., Calcasieu Lumber Co. PROPOSERS: R. W. Barnes, G. R. Rhine. SECONDERS: R. W. Kotzebue, L. S. Pawkett.

SCHULZ, BURNETT J., Student, Texas A & M College. PROPOSERS: J. S. Hopper, W. E. Long. SECONDERS: Carl Files*, E. S. Holdredge*.

SEAT, JAMES H., Sales Engr., Garrard, Sudderth & Seat. PROPOSERS: E. R. Foss, J. J. Joyce. SECONDERS: J. M. Rittelmeyer, C. E. Johnson.

SIMMONS, GEORGE P., Partner, Noah M. Simmons Co. PROPOSERS: G. O. Jackson, N. M. Simmons. SECONDERS: C. H. Hagedon, S. E. Fenstermaker.

SIMMONS, NOAH L., Partner, Noah M. Simmons Co. PROPOSERS: I. W. Cotton, G. O. Jackson. SECONDERS: C. H. Hagedon, S. E. Fenstermaker.

SIMPSON, W A., Secy.-Treas., R. E. Chase & Co. PROPOSERS: T. H. McClung, J. D. Kroeker. SECONDERS: R. C. Chewning, J. H. Bonebrake.

SMITH, ARTHUR J., Engr., J. C. Marlow & Co., Inc. PROPOSERS: J. J. O'Shea, R. B. Stotz. SECONDERS: J. C. Shumate, W. J. McKinney.

STARRETT, FORREST W., Sales Engr., Knight-Randall Co. PROPOSERS: G. D. Winans, C. W. Signor. SECONDERS: E. T. Smith, G. H. Tuttle.

STEILEN, LOUIS J., Chief Engr., Lehigh Engineering Co. PROPOSERS: L. Macrow, L. M. Church. SECONDERS: E. K. Wagner, G. E. Tuckerman.

STRACKE, SAMUEL L., Student, Texas A & M College. PROPOSERS: J. S. Hopper, W. E. Long. SECONDERS: Carl Files*, E. S. Holdredge*.

THAYER, HARDING H., Partner, The Thayer Co. PROPOSERS: F. C. McIntosh, E. C. Hach. SECONDERS: Roy Brauer, J. F. S. Collins, Jr. *(Advancement)*.

TIPPETT, GEORGE R., Student, Texas A & M College. PROPOSERS: J. S. Hopper, W. E. Long. SECONDERS: Carl Files*, E. S. Holdredge*.

VAN WOERT, ANDREW B., Engr. PROPOSERS: C. H. Flink, Philip Drinker. SECONDERS: W. G. Christy, L. J. Wong.*

*Non-Member.

VOSKAMP, EARL L., Student, Texas A & M College. PROPOSERS: J. S. Hopper, W. E. Long. SECONDERS: Carl Files*, E. S. Holdredge*.

VRADENBURG, WILLIAM C., Design Supvsr., North Coast Engineers. PROPOSERS: T. H. McClung, T. E. Taylor. SECONDERS: R. C. Chewning, J. H. Bonebrake

WELCH, THOMPSON I., Student, Texas A & M College. PROPOSERS: J. S. Hopper, W. E. Long. SECONDERS: Carl Files*, E. S. Holdredge*.

WILKE, IRA W., Htg. Engr., Texas Public Service Co. PROPOSERS: R. W. Barnes, F. C. Benham. SECONDERS: R. W. Kotzebue, A. J. Rummel.

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In the past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by **Art. B-III,** *Sec.* 8, of the By-Laws, the following list of candidates elected:

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GUNDERSEN, REIDAR, Engr., Buenos Aires, Argentina, S. A.

HILL, JAMES W., Cons. Engr., Los Angeles, Calif.

MORIN, ROMEO P., Cons. Engr., Manchester, N. H. *(Advancement)*.

OTT, GEORGE W., Chief Mech. & Elec'l. Engr., Montgomery Ward & Co., Chicago, Ill.

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BOYD, SAMUEL W., Branch Mgr., James B. Clow & Sons, Houston Tex.

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COTTER, ROBERT P., Mgr., Htg. & Air Cond. Div., A. J. Monier & Co., San Antonio, Tex. *(Reinstatement)*.

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CITES NEED FOR ENGINEERS

Future demand for engineering graduates will be more than twice as great as before the war, according to Karl T. Compton, president of Massachusetts Institute of Technology.

Despite increased military and civilian demands during the war, the number graduating from engineering schools has declined steadily to a low this year of less than 7000 including those in army and navy sponsored programs. This compares with a normal complement early in the war of almost 15,000.

In an article appearing in the November issue of *Educational Focus*, Dr. Compton predicted that the nation's deficiency in technical manpower "will not be wiped out until 1952 at the earliest."

Dr. Compton pointed out that during the war virtually all of the technical talent focused its attention on the development of equipment and techniques for the single purpose of winning the war. He said:

"Even though a great deal of this research will have peacetime application, we have undoubtedly lost ground in our constructive efforts constantly to improve the standard of living. Further, we have drawn heavily on our reservoir of fundamental scientific knowledge because most of the war research concerned the *application* of science and any basic research was incidental to the major task. We must therefore promptly replenish the supply of the *raw materials* of engineering and science."

The M.I.T. president added that during the war almost every company producing war equipment was dependent in some way on technical manpower, and that this trend will continue in peacetime is borne out strikingly by a survey recently conducted among 125 companies throughout the United States by a committee of the *American Society of Engineering Education*. The results indicate that the future annual demand for engineering graduates will be more than twice as great as before the war.

In conclusion, Dr. Compton declared that the future for the young man in engineering or science is "indeed bright"; that it presents "a challenge and an opportunity that we should not and cannot let pass. Educators and industrialists alike must do everything possible to encourage students at the secondary school level to study basic sciences and to develop in the students an interest in a future career in one of the technical fields."

An Invitation to Members

The Council wishes to encourage authors to contribute good technical papers for presentation to our Society, particularly papers dealing with new or novel developments. Good papers on air conditioning of all kinds and new papers on air distribution, industrial hygiene and industrial ventilation are of interest. A special committee has been appointed to secure papers. The membership of the Committee on Technical Papers is composed of G. L. Tuve, chairman; L. T. Avery, Walter Heibel, C. H. Flink, and Cyril Tasker.

Any one of the committee members will be glad to consult by mail or otherwise with authors to predetermine whether the particular subject is desired.

Papers must be presented first to the Publication Committee for approval for publication and then are passed on to the Meetings Committee for selection to use at the Annual or Semi-Annual Meetings. We need papers planned now to take care of the Annual Meeting in January, 1947. If you have any papers you would like to suggest, please communicate with any of the committee members.

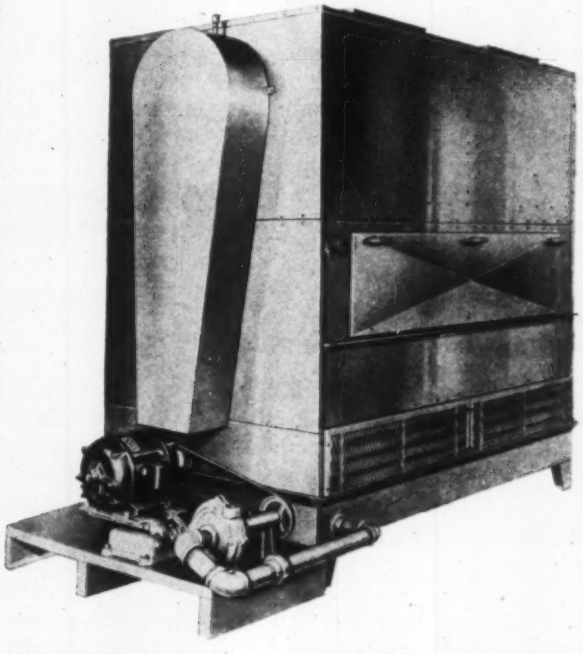
EQUIPMENT DEVELOPMENTS

For your convenience in obtaining more information about any of this equipment, see coupon on this page. Add the new products and companies listed here to your Directory Section which you received in your January 1946 Heating, Piping & Air Conditioning and thus keep your records of sources of supply up to date throughout the year. Single asterisk indicates equipment not listed in Directory Section; double asterisk equipment and manufacturer not listed.

Cooling Towers

No. 3265—A new line of cooling towers for use with unit air conditioners and refrigerating plants of 3 to 50 tons capacity has been announced by Marlo Coil Co., 6135 Manchester Ave., St. Louis 10, Mo.

These compact units are a modification of the company's evaporative condenser; being identical in dimension, design, and construction except in place of the condensing coil a wetted deck surface is provided. They are said to combine the advantages of deck, spray, and fan type towers.



Optional features of these units, which are available in 10 sizes and which incorporate mechanical draft, include stainless steel construction, unidrive or remote pump installation, and the choice of outdoor or indoor location.

Lead Products Division Consolidated

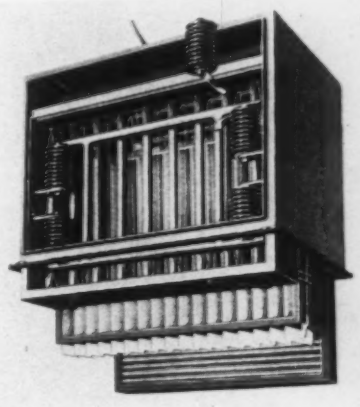
No. 3266—The American Smelting and Refining Co., 120 Broadway, New York 5, N. Y., has consolidated the operations of its Lead Products Div. with those of its Federated Metals Div.

A. P. Knapp, for the last six years general manager of the Lead Products Div. and president of its subsidiary, the Andrews Lead Construction Corp., has acquired the operations of this subsidiary together with the homogeneous bonding business of the Lead Products Div. These operations are being conducted by two newly formed companies of which Mr. Knapp is president. These are Andrews-Knapp Construction Co. and Knapp Mills, Inc. with offices at 120 Broadway, New York City. According to a recent announcement, a close working arrangement will exist between the Federated Metals Div. of American Smelting and Refining Co. and Mr. Knapp's new companies.

Electronic Air Filter for Railroad Cars

No. 3267—A new model "Electro-Airmat" dust filter, designed especialy for railroad car use, has been announced by American Air Filter Co., Inc., First and Central Ave., Louisville 8, Ky.

The collector element of this filter is electrostatically charged "Airmat" paper, a cellulose product composed of a number of plies of tissue-like sheets in "jack-straw" arrangement. Units are available for either side or bottom servicing of the collector element which is approximately 19½ x 26½ x 7 in. and are rated at 950 cfm. The loading of spare elements is done by turning a crank on a mechanical loader or, for small installations, a manual loader may be used. In either case casters can be provided for performing this operation at the track side.



The arrestance rating of the unit, when tested by the discoloration test method, is said to be 90 per cent or better with atmospheric smoke or dust, and the weight of the unit is claimed to be 40 per cent less than electronic filters having metal collector plates, even though 30 per cent less space is required.

The filter is designed to operate on 115 volt, 60 cycle, single phase current with a power consumption of approximately 250 watts.

Heating, Piping & Air Conditioning [11-46]
6 N. Michigan Ave., Chicago 2, Ill.

Please ask the manufacturers to send me more information about the equipment mentioned under the following reference numbers in Equipment Developments and Recent Trade Literature.

(Circle each number in which you are interested)

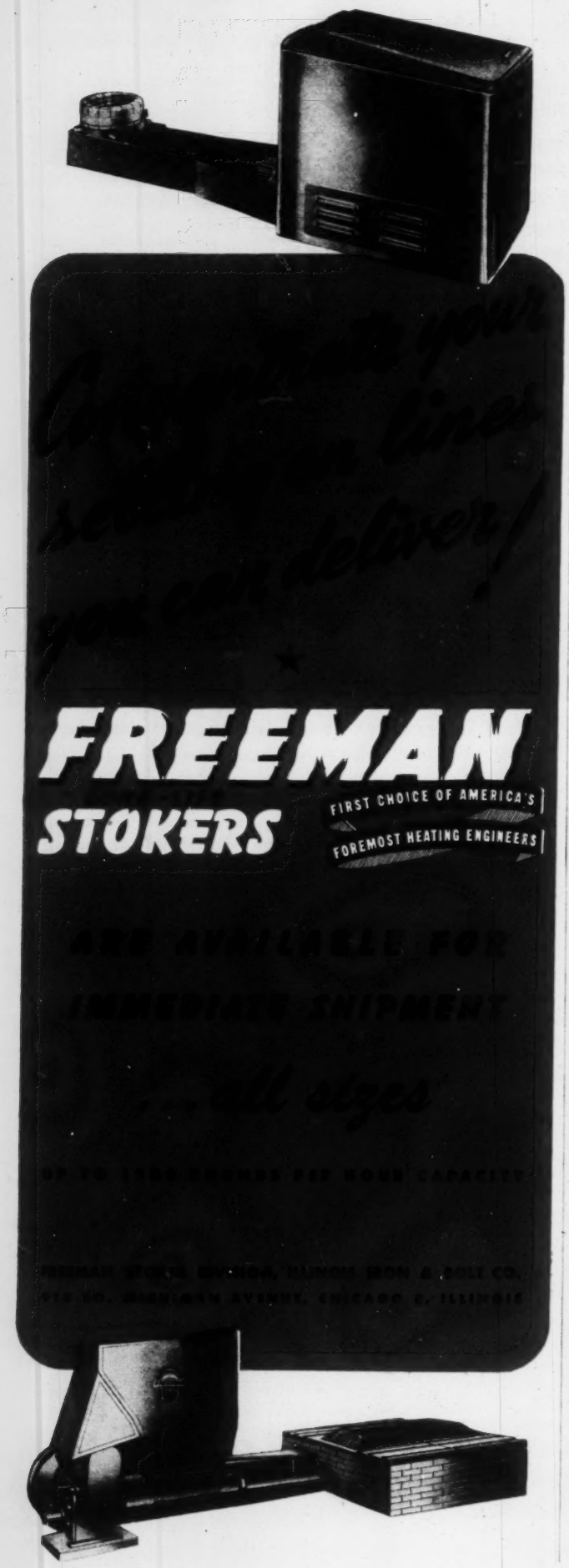
3265	3266	3267	3268	3269	3270	3271	3272	3273	3274
3275	3276	3277	3278	3279	3280	3281	3282	3283	6317
6318	6319	6320	6321	6322	6323	6324	6325	6326	6327
6328	6329	6330	6331	6332	6333	6334	6335	6336	6337
6338	6339	6340	6341	6342	6343	6344	6345		

Name ..... **Title** .....

Company .....

Address .....

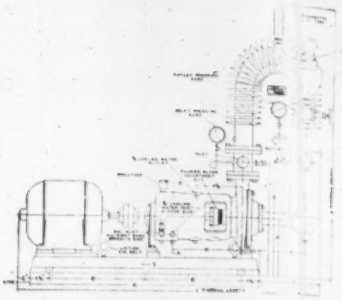
City ..... **Zone** ..... **State** .....



Pump for Condensate Return System Redesigned

No. 3268—The use of a newly redesigned and larger pump in the C-B high pressure condensate return system has been announced by the Cochrane Corp., 17th St. and Allegheny Ave., Philadelphia 32, Pa.

The larger pump, driven by a 25 hp motor, has been added to handle larger capacities and the outboard pump shaft bearing has been eliminated in favor of a closer coupling. Other changes are said to include the use of a better adapted flexible coupling between the pump and motor and the use of a silent jet which reduces pump noise.



In operation the centrifugal pump draws water from a finned priming loop and discharges it as a high velocity jet through the jet pump nozzle. This jet draws the returned hot condensate through a venturi-shaped mixing tube and into the priming loop. The additional volume of condensate introduced into the constantly filled loop results in the discharge of an equal volume through the air separator to the boiler.

The system is designed to handle up to 75,000 lb per hr of condensate at an 80 psi boiler pressure differential.

Refrigeration Equipment Manufacturer Buys New Plant

No. 3269—The Baker Ice Machine Co., Inc., 1531 Evans St., Omaha 1, Neb., manufacturer of refrigeration and air conditioning equipment, has purchased an additional manufacturing plant at Portland, Me.

The Portland plant, formerly used for war production, will add 60,000 sq ft of manufacturing space to the Baker facilities and will be in operation as soon as machine tools can be installed. The addition of the eastern plant is one of the early steps in the expansion program of the company which was acquired last October by the Equity Corporation Group. While other manufacturing operations are carried on at Seattle and Los Angeles, the new plant is expected to be second in output to the Omaha factory.

President Ross Rathbun has announced the appointment of J. H. Hill as assistant comptroller.

Acidity and Alkalinity Indicator

No. 3270—A new "Methyl-Purple" indicator, designed to replace methyl-orange as a titration indicator in determining acidity and alkalinity, has been announced by the Fleisher Chemical Co., P. O. Box 616, Benjamin Franklin Station, Washington 4, D. C.

Laboratory control of acidity and alkalinity plays an important part in the manufacture of a great many products and in water conditioning, such as boiler feedwater. Laboratory tests are generally conducted with the aid of titration indicators, and according to the manufacturer, the new indicator is superior to the

DOWELL

Fire tube boilers cleaned quickly

—designed operating efficiency restored!

The Dowell chemical method of cleaning fire tube boilers has grown steadily in acceptance by plant engineers who appreciate the advantages of a *modern* cleaning technique which combines rapidity with effectiveness and safety. Reduced operating costs naturally follow when accumulated scale and sludge are chemically removed from boilers, condensers, flow lines, and other types of heat-exchange equipment.

Dowell offers a complete service—including preliminary inspection, scale analysis, and the selection of proper chemicals to accomplish rapid cleaning. Dowell specialists bring with them adequate equipment to control every stage of the successful treatment.

EE SHOWING! Now available—a new minute sound slide film illustrating the bilities of Dowell Chemical Scale Removal ice. A Dowell representative will gladly nge a special showing at your plant, office or nization meeting. Call or write Dowell today.

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Subsidiary of The Dow Chemical Company

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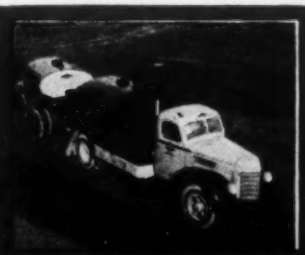
Long Beach, Cal., Casper, Wyo.: Dowell Affiliate—International Cementers, Inc.

SPECIALISTS IN CHEMICAL CLEANING SERVICE



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FOR INDUSTRIAL CHEMICAL SERVICE

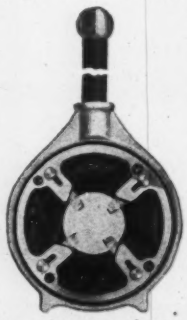
Less Work More Speed

threading 1" to 2" pipe with this No. 1R poster

RIDGID

Has the famous RIDGID quick-setting workholder

● This improved No. 1R gives you pipe threading speed and convenience you're not used to finding in a 1" to 2" poster die stock. Mistake-proof workholder sets to size quickly, only 1 screw to tighten on pipe . . . no bushings to bother with. Direct action threading, no wobble—full-floating posts only taper threads. Fast smooth-threading alloy or high-speed steel dies, rugged steel-and-malleable construction for long use. Popular price—ask your Supply House.



It stands up anywhere on its own feet.

RIDGID

WORK-SAVER PIPE TOOLS

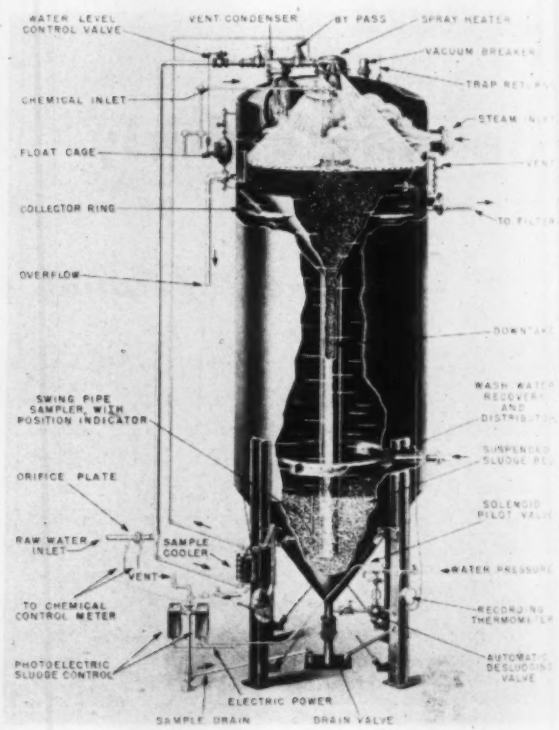
THE RIDGE TOOL COMPANY • ELYRIA, OHIO, U. S. A.

well-known methyl-orange because (1) there is no interference from phosphates, organic matter, etc., (2) endpoints actually coincide with the equivalent points, (3) color transitions take place over a narrow pH range, (4) color changes are contrasting and definite and the sharp endpoints make results reproducible and reduce the time required for titration, (5) a convenient warning tint provides a signal of approaching endpoint, and (6) the indicator is completely stable as alcohol or other volatile solvents are not used.

Hot Process Water Softener

No. 3271—A new hot process water softener, incorporating a sludge blanket design, has been developed by the Permutit Co., 330 W. 42nd St., New York 18, N. Y.

Improved boiler feedwater, substantial savings in chemicals required for softening, and reductions in turbidity of softened water, the load on filters, the amount of backwashing, and the amount of silica left in the water are said to be some of the features of this new equipment which is built in four models for use with every type of steam generator.

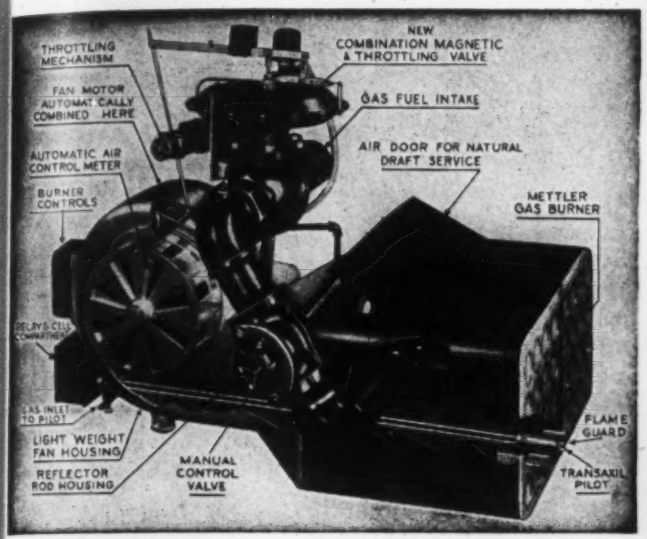


In the tank, suspended sludge forms a bed which acts as a filter screen for fine particles. This bed, coupled with a slow rate of upward flow throughout the settling tank, is said to give an effluent lower in turbidity than that obtained in other types of softeners. This low turbidity in the settled water, says the manufacturer, places a relatively light load on the filters, and this in turn, produces a corresponding reduction in the frequency of backwashing.

An unusual feature of the unit is said to be the use of an automatically operated desludging valve for controlling the depth of the sludge bed. The valve is actuated by an electronic turbidity detector which continuously measures a water sample passing through the bed.

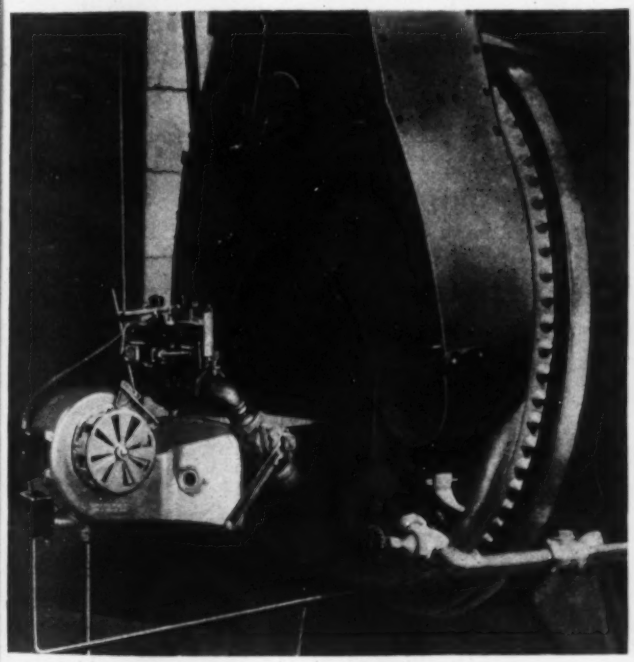
The Gas Burner "FAN-AIR"

EXPERTO CREDE



Picture reveals essential and highly desirable POINTS of Fan-Air mech'l draft gas burners. Not just a gas burner but a COMPLETE AND FULLY AUTOMATIC BURNER SYSTEM, factory tested and ready for application when received. It's the most modern gas burner and easier to install.

SIZES 5 to 300 H.P. PROMPT SHIPMENTS



Worthy of sponsorship for **Scotch Marine Boilers**

Nothing else like it!

LEE B. METTLER CO.

406 South Main Street

LOS ANGELES 13 CALIFORNIA

A smart pipe vise and workbench

Easily set up

where you need it

RIDGID

Portable

TRISTAND

● It makes sense that this efficient Tristand, practically a portable workbench, becomes more popular by the month. Hinged legs fold in for easy carrying to the job. It sets up solid against tipping. Ample room on top, slots for tools, a pipe rest and three handy pipe benders . . . remarkably convenient. Comes with chain or yoke pipe vise, LonGrip jaws easy on polished pipe. Strong malleable construction, years of easier pipe work. Ask your Supply House for the RIDGID Tristand.

Tristand made also with yoke vise.

RIDGID

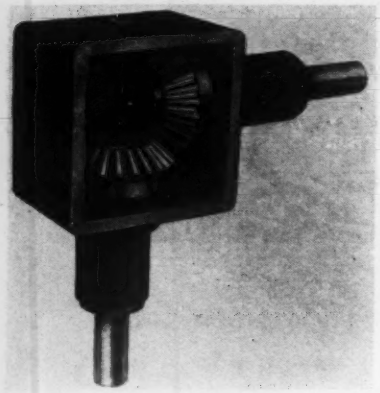
WORK-SAVER PIPE TOOLS

THE RIDGE TOOL COMPANY · ELYRIA, OHIO, U. S. A.

Miter Gear Box

No. 3272—A new line of miter gear boxes for shafts from ½ to 1½ in. has been announced by the Brooks Equipment Corp., 217 Hudson St., Hoboken, N. J.

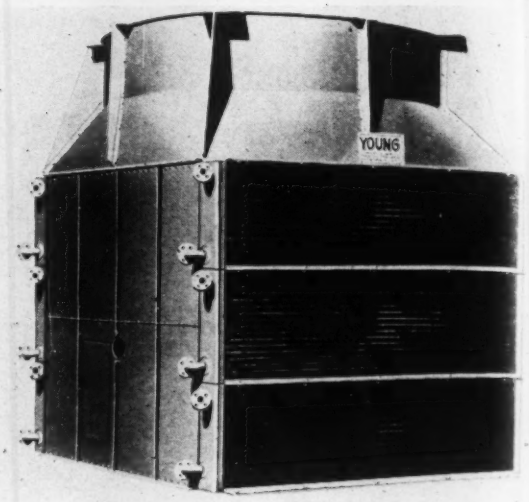
Designed for standardization, economy, high efficiency, and ease of installation, the units are said to provide great strength and resistance to shock. Oilite bearings are provided in the long hubs and both the plain and oil sealed types of boxes are available. Horsepower ratings are in accordance with standard power transmission practice.



Large Capacity Cooling and Condensing Radiators

No. 3273—A series of new type, large capacity cooling and condensing radiators, designated as VAD units, has been announced by the Young Radiator Co., Racine, Wis.

Designed for water cooling, oil cooling, steam and vapor condensing, gas cooling, or in combination arrangements, cooling faces are located on two opposite sides of the unit and an induced draft fan is used to provide a vertical air discharge. Tube and fin coils mounted in a vertical plane are said to provide simplified manifolding to supply and return lines, and the independently mounted fan and drive assembly is designed to eliminate the transmission of vibrations.



Capacities for the water cooling units range upward from 3,600,000 Btu per hr at standard conditions.

Industrial Controller

No. 3274—The Foxboro Co., 106 Neponset Ave., Foxboro, Mass., has announced the new model 40 controller for the control of temperature, pressure, flow, and other variables in continuous processes, or others in which the control requirements are exacting.

YOU HAVE MANY WAITING BUYERS For this

THERMOSTATIC HEAT REGULATOR SET

. . They're the Owners of A-P Controlled Oil Heaters Purchased from You since 1939!

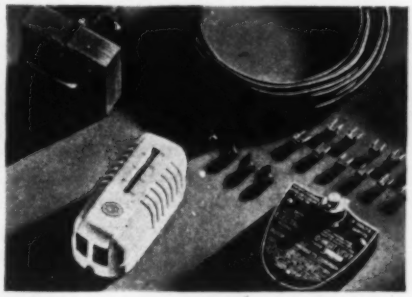
Take your Oil Heater Customer-list out of "mothballs." Make it an active source of extra sales and profits! Offer every one of these old friends the modern luxury and oil-saving convenience of *Automatic* Temperature Control for their heaters. Show them how savings in avoiding *overheating* can practically pay the low cost of the complete A-P Model 240-ED Heat Regulator Set. Tell them how they'll save time, enjoy more uniform healthful room temperatures by regulating their heaters by the mere setting of a *Thermostatic Dial*

Any Vaporizing Oil Burning Heater using the A-P 240-DR or UR Constant Level Oil Control can be equipped with this AUTOMATIC Heat Regulator Set. This means most of the leading makes produced since 1939. It's *easy to install*, too. Complete "Sales Package" includes an Electric Conversion Top which mounts on present manual control, an attractive and accurate Wall Thermostat, a Transformer, and all necessary accessories and instructions, for simple and quick installation.

Write TODAY for prices, samples, and other advertising and selling material — to help you to EXTRA sales and profits this winter.

AUTOMATIC PRODUCTS COMPANY
2460 NORTH THIRTY-SECOND STREET, MILWAUKEE 10, WISCONSIN

MODEL 240-ED Heat Regulator Set.
Adds AUTOMATIC Temperature Control to all Oil Heaters equipped with A-P Model 240-DR or UR Manual Controls.



Be SURE your new Heater Lines are equipped with A-P DEPENDABLE Oil Controls — for faster sales, greater customer satisfaction.

DEPENDABLE *Oil Controls*
DESIGNED TO ELIMINATE SERVICING

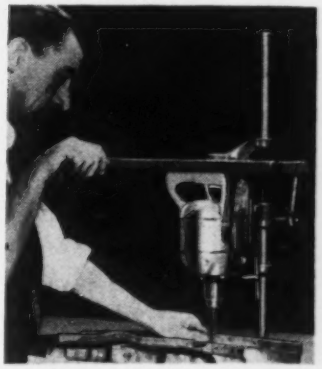
Either Way You Save Time with this Versatile Tool!

Use It as a PORTABLE DRILL

The Black & Decker 5/16" Heavy-Duty Drill is full-powered, built for continuous use. Drives twist drills up to 5/16" in piping, steel plates, ducts, vents, frames, braces and other metal parts. Drives wood augers up to 5/8" in hardwood for running pipe through flooring and walls, installing heating and air conditioning units. Drives B & D Hole Saws up to 1½" diameter for cutting clean, round holes in any material a hacksaw will cut.

Use It as a DRILL PRESS

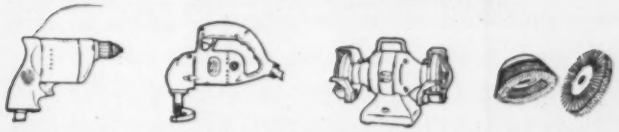
Mounted quickly in a Black & Decker No. 20 Drill Stand, this Drill makes a powerful drill press. Plenty of leverage to put on the pressure. A slow, smooth feed for more precise work. You can use the same Drill for both portable and stationary work!



For full information on Drills and other Electric Tools for heating, piping and air conditioning work, see your nearby Black & Decker Distributor. For our complete catalog, write to: The Black & Decker Mfg. Co., 628 Pennsylvania Ave., Towson 4, Maryland.

LEADING DISTRIBUTORS EVERYWHERE SELL

Black & Decker
PORTABLE ELECTRIC TOOLS



ELECTRIC DRILLS ELECTRIC SHEARS BENCH GRINDERS WIRE BRUSHES

Takes a lot of your work out of cutting pipe...this *fast-action 4-wheel* RIDGID pipe cutter

Regular Heavy-Duty RIDGID *Cutters in 5 sizes.*

Good reasons why this 4-wheel RIDGID pipe cutter is such a favorite everywhere. It cuts pipe fast and clean with least effort. Designed with short handle to work in tight quarters, it cuts quickly even where you have room only for a quarter turn. Special malleable body assures alignment, it always cuts true — every cutter factory tested. You'll like this efficient worksaver RIDGID — ask for No. 42 (1/2" to 2") or No. 44 (2 1/2" to 4") at your Supply House.

RIDGID

WORK-SAVER PIPE TOOLS

THE RIDGE TOOL COMPANY · ELYRIA, OHIO, U. S. A.

For Insulation Jobs, too

IT HAS TO BE RIGHT THE FIRST TIME

. . . and the first choice for the right insulating job is the Johns-Manville Insulation Applicator.

Even the finest insulation must be properly applied to provide maximum efficiency. That's why leading refrigeration engineers have long relied on the combination of Johns-Manville Rock Cork and the skill of J-M Applicators.

Basically mineral in composition, Rock Cork is made in both sheet and pipe-covering form. Both provide advantages that plant operators and engineers appreciate . . . low thermal conductivity, exceptional resistance to rot, moisture and vermin.

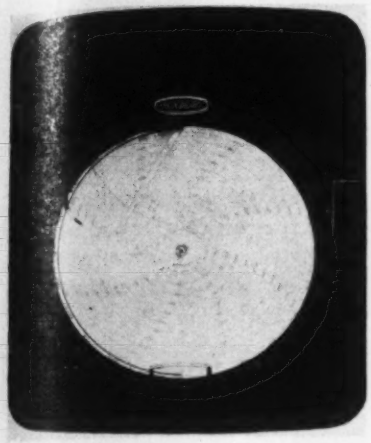
And you can be sure that Rock Cork will be applied to give you maximum use of its high insulating efficiency. J-M Insulation Applicators are fully trained in all phases of application. They employ only skilled mechanics and the most up-to-date methods of application.

For further details, write for brochure DS-555, or see your J-M Insulation Applicator. Johns-Manville, Box 290, New York 16, N. Y.

JM

Johns-Manville

ROCK CORK



The new unit does not represent any departure in basic operating principles from the model 30 unit (which it replaces) but embodies improvements in design and construction which offer new advantages. Features are said to include simplification of design, more sturdy construction, easier and more flexible adjustments, and new conveniences in servicing, including the easy replacement or interchange of unit parts. The controller is made as an indicator as well as a single pen and multi-pen recorder and is available for on-off control action, proportional, proportional and reset, proportional with derivative, and proportional and reset with derivative.

CO_2 Recorder

No. 3275—Davis Emergency Equipment Co., 201 Halleck St., Newark 4, N. J., has announced a new CO_2 recording instrument which is said to be extremely sensitive.**

According to the manufacturer, the extreme sensitivity to changes in CO_2 content in the flue gas causes a quick response so that the instrument can record a change 3½ sec after the variation has reached the analyzing cell, and since the cell is located close to the stack, the change is indicated almost as soon as it occurs. Other features are said to include the elimination of continuously operating suction pumps, the use of low flow rates through the sampling tube (20 to 250 cc per min) which eliminates the need for filtering trains and dryers.

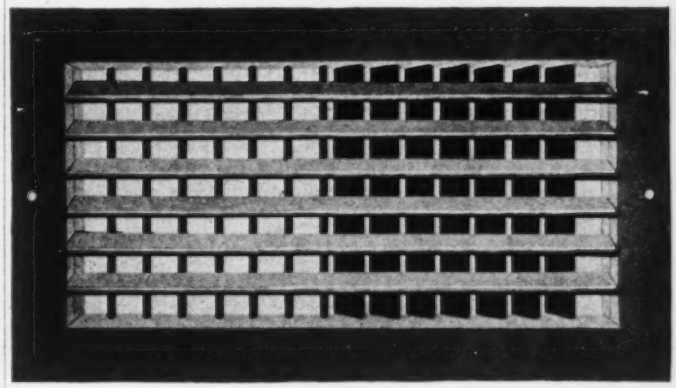
To continuously record changes in CO_2 content, as determined by the analyzing cell, a Brown continuous balance, electronic recorder is used. This is furnished with 24-hour circular charts which have a range fom 0 to 20 per cent CO_2. The cell panel is a complete unit and is mounted adjacent to the stack at the sampling point. The control cabinet and recorder are panel mounted at any convenient location, and d-c current for operation of the complete unit is provided through a constant potential rectifier.

Self Contained Air Conditioning Unit

No. 3276—The "Gemco" packaged air conditioning unit, available in both the three and five ton sizes and utilizing a two stage compressor which is constructed largely of aluminum alloy, has been announced by General Engineering & Mfg. Co., 1523 S. 10th St., St. Louis 4, Mo.**

Designed for cooling, dehumidifying, and circulating air in homes, stores, offices, and shops, the unit is provided with space for the optional installation of a heating coil and humidifier which can be used with an existing steam or hot water system. Standard units are furnished with a four-row expansion and cooling coil, but another optional feature is the use of a six-row

HIGH VELOCITY OUTLETS



HIGH VELOCITY OUTLET

Adjusted for Down Throw and to One Side

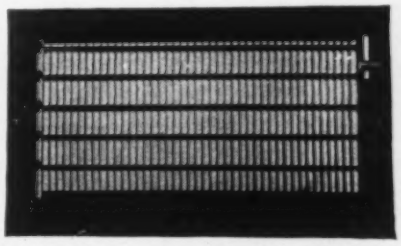
Style "DDH" illustrated above is one of eight variations of our high-velocity outlet—each bar individually adjustable with key furnished—with or without volume valves. Supplied with baked prime coat and sponge rubber gasket.

This is a heavy, attractive outlet made in all sizes, with matching fixed-bar down-deflecting return grille. Prices are competitive.

Prompt shipment of this line is available.

MANUFACTURERS OF ROOM COOLERS

We are in a position to supply variations of the High Velocity Outlet illustrated above, curved to follow the contour of your cabinet, or straight. Your inquiry is invited for prompt, helpful information.



Style 74—Register—Wall or Baseboard. This Register utilizes 1" multiple-dampers to control volume and vertical direction. Multiple dampers may be set so as to obtain up, straight, or down deflection, as well as complete shut-off. The face is the same as all others of the "70" line—permitting air reflection right or left by adjusting front blades with key furnished. Blades are ¼" center to center, and ¼" in depth. Complete with rubber gasket, screw holes, prime coat. This is an attractive, well-constructed register, available promptly.

For immediate quotation and literature, Ask for Bulletin H11.

STEWART MANUFACTURING COMPANY
INCORPORATED
BLOOMFIELD, N. J.

coil which is recommended for use in extremely humid areas.

One of the outstanding features, says the manufacturer, is the use of a two stage, four cylinder, semi-hermetically sealed compressor which is constructed almost entirely of heat treated aluminum alloy. This is said to provide not only light weight but high compressor efficiency under varying load and cooling water conditions. In fact, satisfactory operation is said to be possible even though the cooling water supply may be limited or relatively high in temperature. Unloading devices are not used as the unit is designed for a balance of pressures on the low side after shutdown. The electric motor is cooled by refrigerant gas through the motor housing; the heat being transmitted to the condenser.

Safety Control for Pumps

No. 3277*—Automatic Control Co., 1005 University Ave., St. Paul 4, Minn., is offering the "Protectrol," a pressure switch designed to shut off deep well or centrifugal pumps when water is not being discharged.

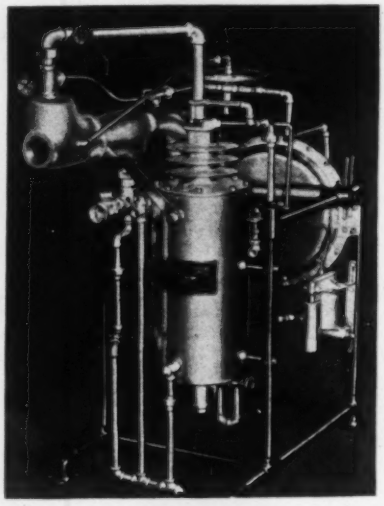
The device is connected to a pressure tap at the pump discharge on the pump side of the check valve and is powered by an independent line circuit. A thermal time delay unit, adjustable from 45 sec to 2½ min, which is powered from the motor side of the magnetic starter, shuts the pump off after it has been in operation a predetermined time without creating head pressure at the tap. In this way the device is designed to protect the pump and motor where mechanical failure, lowering of the water table, or any other cause results in water not being discharged.

The device is not a primary control for automatically starting and stopping the pump. It is used in conjunction with a primary control, either automatic or manual, and locks the pump out until manually reset —regardless of primary control operation.

Vaporized Oil Can Substitute for Gas

No. 3278—A newly redesigned and improved "Vapofier" unit for converting fuel oil to a vapor which is mixed with air, piped, burned, and controlled in the same manner as utility gas has been announced by the Vapofier Corp., 10316 S. Throop St., Chicago 43, Ill.

In the operation of the unit, No. 1 fuel oil is burned in a combustion chamber and the resulting hot gases are used to vaporize oil of the same grade. The vapor thus created is drawn off through a premixer where air for combustion is added. According to the manufacturer, the fuel-air ratio may be predetermined and maintained throughout the entire range of capacity, and in addition, flame quality



TALLMADGE ZONED CONTROLLED HEATING SYSTEMS

For better Heating at less cost

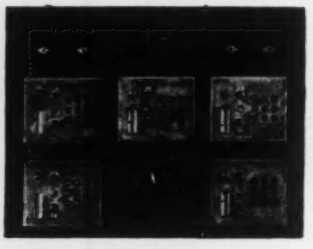


Figure 1

Figure 3

Figure 4

Figure 2

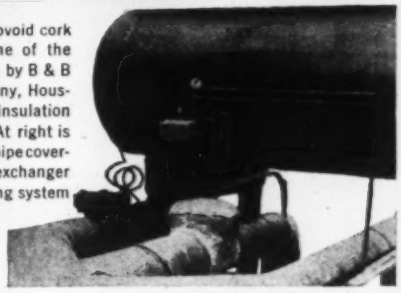
Figure 5

THE TALLMADGE equipment shown above is for a Zoned Heating System, either automatic or remote control (Figure 1). Airotherms, (Figure 2) for outside control, determine the heating requirements and set Pressure Boxes (Figure 3) to regulate the steam pressure to each zone. Zone valves (Figure 4) control the steam passing to the radiators. Orifices (Figure 5) meter the steam entering the radiators.

ADVANTAGES: Precise control of steam. Elimination of over-heating and costly waste of fuel. Low cost of maintenance. Saving on outlay for original equipment. Greater comfort to occupants due to steady heat and modulated even distribution.

WEBSTER TALLMADGE & CO., Inc. 364 Glenwood Ave., East Orange, N. J.

All over America leading Insulation Contractors install NOVOID



Shown above are some of the Novoid cork pipe fitting covers stored in one of the several warehouses maintained by B & B Engineering and Supply Company, Houston, Texas, one of the foremost insulation contractors of the Southwest. At right is shown Novoid cork lagging and pipe covering installed by this firm on the exchanger and piping of an air-conditioning system in Beaumont, Texas.

YOUR ORDER for delivery of Novoid Cork Pipe Covering can now be filled promptly. Contractors throughout the country can furnish a wide variety of sizes and thicknesses of Novoid, ready for immediate installation.

Novoid Covering is the moulded rigid insulation that efficiently reduces your cost of refrigeration. It snugly hugs pipes and fittings of every size and shape, does not sag, does not absorb moisture or odors, and is long-lasting.

For complete facts about Novoid Corkboard, Pipe Covering, and sundries specially developed to make low-temperature insulations most efficient, write to Cork Import Corporation, 39 Park Place, Englewood, New Jersey.

NOVOID INSULATION

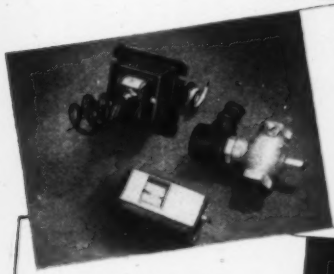
CORKBOARD · PIPE COVERING

Automatic CONTROLS...

Buy the Package

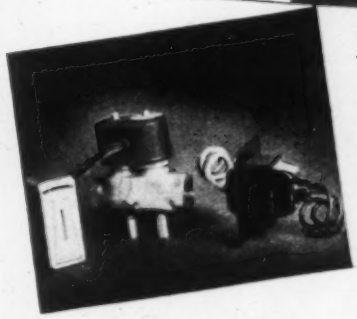
GENERAL CONTROLS presents four of their convenient packaged sets for compact inventory and simple installation. Here are four of many precision built, field proved package sets most frequently desired by gas heating contractors and engineers. Buyers can select complete sets in compact cartons, each set includes essential units required. Get improved performance at lower costs through ENGINEERED adaptability.

T-90 STANDARD THERMOMETER SET
Set combines improved B-60 gas valve, flush mounting Thermometer Thermostat and Pilot Generator. Positive remote temperature control for gas-fired furnaces.



T-30 GAS HEATING SET
This set includes silent K-38 two-wire gas valve, T-70 two-wire metrotherm, and 115-24 volt transformer. Ideally adaptable to gas-fired boilers, wall and floor furnaces, conversion burners and warm air furnaces.

BX-230 STANDARD THERMOSTAT SET
BX-230 includes B-60-68 diaphragm gas valve, PG-6 Pilot Generator, and T-80-4 Thermometer type Thermostat with night cut-off. For wall and floor furnaces, circulators, etc.



T-40 GAS HEATING SET
This set includes two stage Thermostat, dual solenoid valve and Transformer. Provides fully automatic, hi-low firing, maintaining ideal temperature control and lower fuel cost.

For complete specifications covering the GENERAL CONTROLS broad line of *Automatic Pressure, Temperature and Flow Controls* see the new 1946 Catalog 52C. For Gas Heating Controls, request Service and Instruction Manuals.

GENERAL CONTROLS
801 ALLEN AVENUE · GLENDALE 1, CALIF.

Manufacturers of Automatic Pressure Temperature & Flow Controls

FACTORY BRANCHES: PHILADELPHIA • ATLANTA • BOSTON • CHICAGO • DALLAS KANSAS CITY • NEW YORK • DENVER • DETROIT • CLEVELAND • PITTSBURGH HOUSTON • SEATTLE • SAN FRANCISCO • DISTRIBUTORS IN PRINCIPAL CITIES

may be varied from oxidizing to reducing.

The unit, which is designed for use on many industrial applications where temperatures from 150 to 3000 F are required, may be used as a utility gas premixer. By closing the valve to the combustion chamber, utility gas is mixed with air and then piped to the burners. In the event of utility gas rationing, failure, or shutoff, or as conditions regarding the relative prices of gas and fuel oil dictate, oil vapor may be substituted and piped to the same burners without interruption.

The unit requires only 2 ft x 4 ft of floor or ceiling space and is manufactured in eight standard sizes with capacities from seventy thousand to two million Btu per hr.

Gas Heating Controls

No. 3279—Fifteen new or improved gas heating controls have been announced by Minneapolis-Honeywell Regulator Co., 2604 4th Ave., S., Minneapolis 8, Minn.

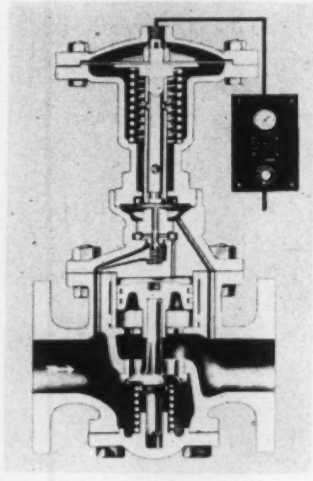
An electronic "Protectorelay" was featured in the company's display at the exhibit of the Gas Appliance Manufacturers' Association where these instruments were unveiled. Operated by a room thermostat the unit combines a gas heating control circuit with an electronic network which, in combination with a flame electrode, is designed to provide ignition and flame safety control for an automatic electric-gas pilot or a direct-ignited gas burner. Electric ignition functions each time the controller calls for heat and is quickly returned on momentary flame failure. Safety shutdown occurs on ignition failure or loss of flame.

Other products introduced at the show include a combination furnace fan and limit control, a thermal fan timer, a compensated controller for forced warm air utilizing both an inside and an outdoor element, together with various types and combinations of gas valves and pressure regulators.

Regulating Valve Remotely Adjusted

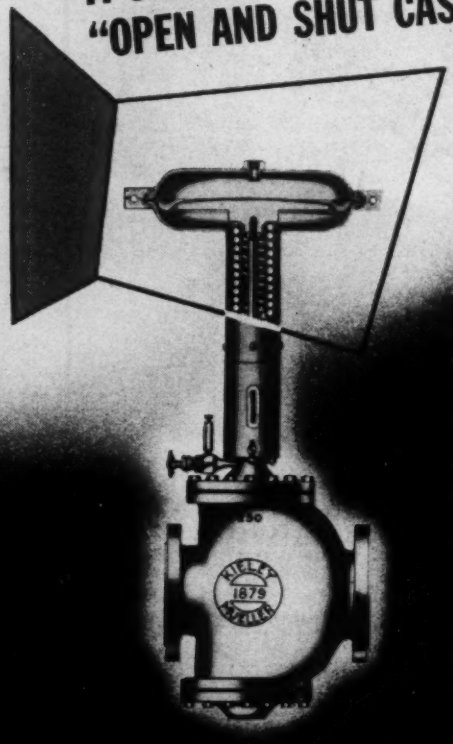
No. 3280—A new single-seated, internal pilot, piston operated reducing valve designed to be adjusted from a remote air loading panel, has been announced by the Leslie Co., 51 Delafield Ave., Lyndhurst, N. J.

Known as Class LT-3, this valve together with the Type ARP air loading panel, is said to be especially suitable for process piping arrangements, particularly steam heating systems that require adjustments of inaccessibly located reducing valves.



In operation, the valve is adjusted to the desired pressure setting by air pressure supplied from the air loading panel which includes a small combination pressure reducing and relief valve (no continuous leakoff), an adjusting knob, and an air pressure gage.

IT'S AN "OPEN AND SHUT CASE"



for K&M's Revolutionary

KONTROL MOTOR DIAPHRAGM VALVE

Just two simple quick-acting clamp screws to loosen, and your diaphragm casing is off. Tight-sealing clamp ring eliminates multiple bolts completely. Duo-seal molded diaphragm lips are automatically self-sealing.

67 years of control engineering "know how" produced this revolutionary new KONTROL MOTOR . . . featuring these design innovations:

- Pressed Steel Diaphragm Casing . . . lighter . . . tougher, more durable.
- Rigid Welded Steel *Tubular* Yoke.
- Long calibrated Steel spring . . . fully enclosed.
- Enclosed ball bearing Spring Adjusting Screw.
- Streamlined Flow Valve Body with high capacity . . . unrestricted flow areas.
- Super-finished Disc Guides, honed guide bushings, top and bottom . . . for minimum friction; increased life.

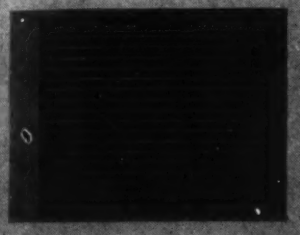
Used with air operated instruments or auxiliary pilot units, the K & M KONTROL MOTOR regulates the flow of steam, liquids or gases — efficiently and sensitively. Send us your control problems. We'll show you how the KONTROL MOTOR valves will solve them. Write for new KONTROL MOTOR bulletin.

KONTROL KIELEY & MUELLER MOTOR

KIELEY & MUELLER, INC., North Bergen, New Jersey

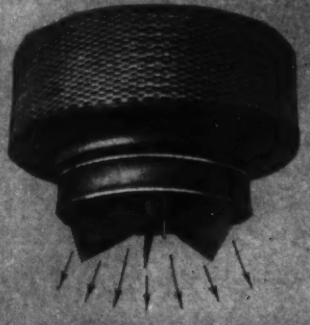
McCORD
HEATING AND AIR CONDITIONING PRODUCTS

BLAST HEATING COILS—AIR CONDITIONING COILS—ALL TYPES



All copper spiral fin tube construction with the tubes formed or bent permits uniform expansion without strain. Headers are heavy wall construction with tubes brazed into extended ferrules formed in the headers. Fins are helically wound and metallically bonded. May we send catalog?

VERTICAL TYPE UNIT HEATERS



A proven heating unit, modern in design, incorporating every unit heater advancement. McCord copper spiral fin tube construction creates air turbulence without undue restriction. Improved fan blades deliver large volume of air with minimum air noise. Guaranteed for 150 lbs. saturated steam pressure. Specify McCord.

HORIZONTAL TYPE UNIT HEATERS

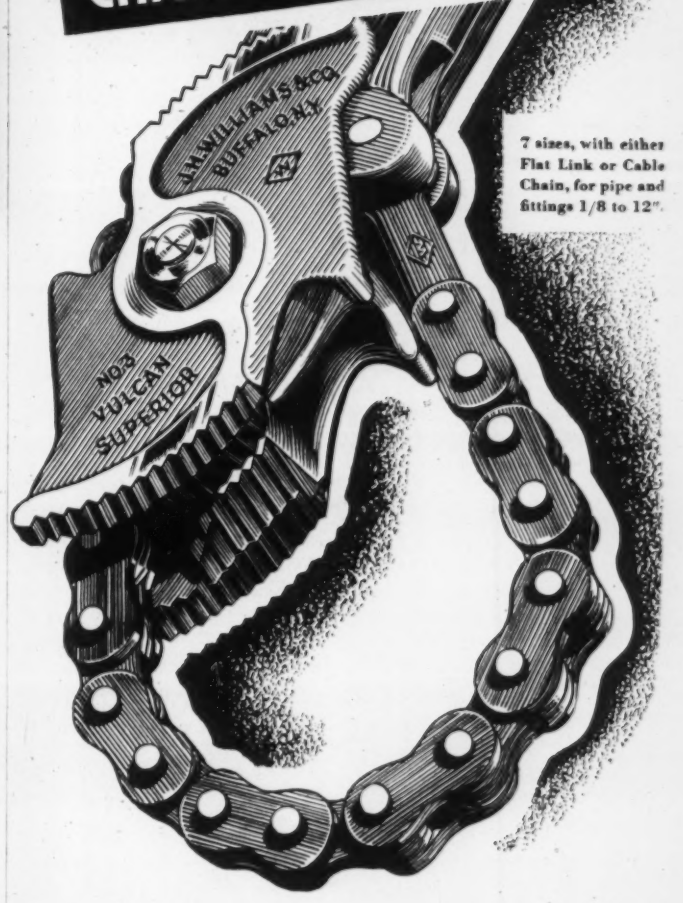
A time proven heating unit, modern streamlined in design, quiet, yet its rugged construction adapts it to all types of installations, guaranteed for use on No. 150 p. s. i. steam pressure. All copper heating element, individual spiral fin tubes free to expand without strain on joints. Standard motors with standard bases used. Wide range of capacities.

Save fuel with McCord Unit Heaters.

McCord CORPORATION
DETROIT 11, MICH.

WILLIAMS
SUPERIOR DROP-FORGED TOOLS

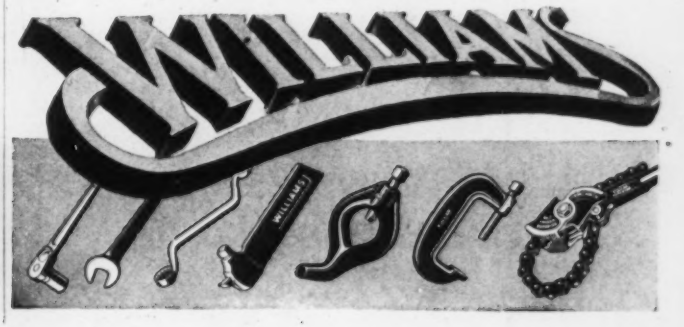
"VULCAN SUPERIOR" CHAIN PIPE TONGS



7 sizes, with either Flat Link or Cable Chain, for pipe and fittings 1/8 to 12".

● Pipe or fittings—it makes no difference to "Vulcan Superior," the universal service tong. You can switch from one to another without adjustment or change of parts. And "Vulcan Superior" is the only chain tong with *reversible* pipe-and-fittings jaws. When one set of teeth begins to wear, simply remove the Through-Bolt and reverse the jaws. Sold by Plumbing Supply and Industrial Distributors everywhere. Literature on request.

J. H. WILLIAMS & CO., BUFFALO 7, N. Y.

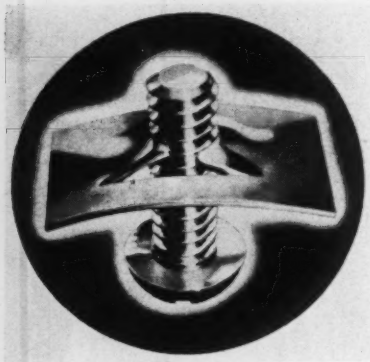


Furnished with bronze or cast steel bodies with flanged or screwed ends, these valves are said to have completely interchangeable replacement parts, stellite seated rings, and hardened stainless steel (800 Brinell) main valves as standard equipment.

New Series Speed Nuts

No. 3281—A new low-priced line of heat-treated spring steel "Speed Nuts," Series C7000, has been announced by Tinnerman Products, Inc., 2018 Fulton Rd., Cleveland 13, Ohio.

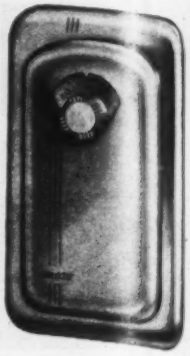
This new line is said to include all the sizes required to fit the ten most popular sizes of machine screws and sheet metal screws. The manufacturer also states that these nuts are compact, will withstand high torque, will provide great tensile strength, and are relatively low in cost.



Room Thermostat

No. 3282—A new room thermostat, Model CD109A, has been introduced by Cam-Stat, Inc., 2037 S. La Cienega, Los Angeles, Calif.

Designed to blend harmoniously with any room interior, and no larger than an ordinary light switch, the unit is said to incorporate superior design, efficiency, and safety features. It is also said to be ideally suited for use on trains, buses, airplanes, and ships as well as in the domestic and commercial heating and ventilating fields.



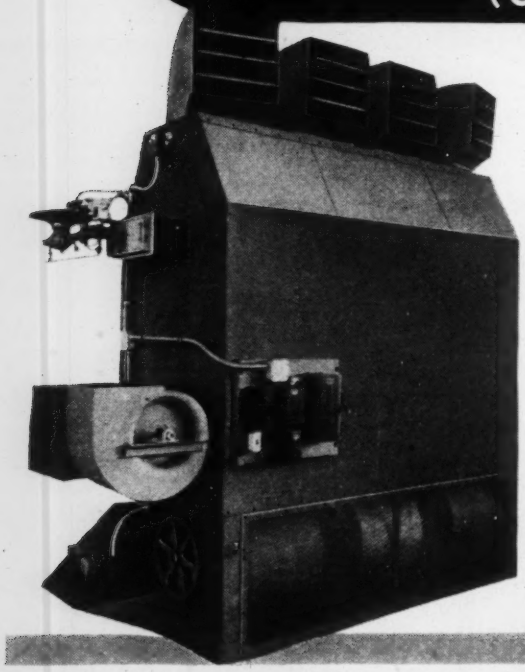
Current carrying capacity is 1500 volt-amps, ¼ hp, and 125 volt-amps pilot duty at 120-240 volts, a-c. The temperature range is standard at 50-100 F with a differential of 2-3 deg. Switching arrangements are SPST break or make on temperature rise, SPDT, and independent circuit double throw.

Nonmetallic Hot Air Ducting

No. 3283*—"Multi-Flex," a nonmetallic hot air ducting for aircraft, has been developed by the United States Rubber Co., 1230 Sixth Ave., New York 20, N. Y.

Said to weigh less than one half as much as aluminum tubing and to handle air temperatures up to 500 F, the material is made of glass fabric impregnated with heat-resistant rubber and plastics. It can be made rigid or flexible, in sizes from 1 to 6 in. in diameter and up to 8 ft in length.

More Efficient Heating With
AIRTHERM Direct-Fired Warm Air Heater
(Oil or Gas Fired)



Direct heat transfer through a single thickness of metal results in the high efficiency and low operating cost of the Airtherm Direct-Fired Warm Air Heater. The Airtherm is a self-contained heating system — ready to connect to your fuel and power supply lines.

Capacities from 650,000 to 1,950,000 B.T.U.'s. Either oil or gas-fired.

Write for Bulletin 801 describing this economical heater in detail.

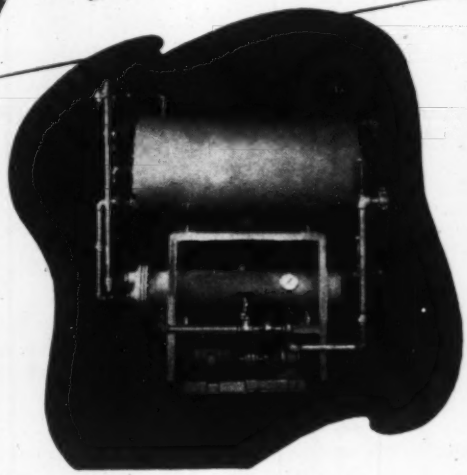
"See our exhibit Seventh International Heating & Ventilating Exposition Cleveland, Ohio, January 27-31,1947."

AIRTHERM
MANUFACTURING COMPANY
AT-43
711 So. Spring Ave. • St. Louis 10, Mo.

Check ...

THESE MONEY-SAVING ADVANTAGES OF THE SCHAUB *Heat Reclaim* SYSTEM!

1. All heat units in the high pressure returns above 212° are recovered and put to work.
2. "Flash" steam—paid for as fuel—is reclaimed and transferred to the feed water on the way to the boiler.
3. With Schaub "Heat Reclaim," feed water temperatures range from 240° to 260°.
4. Automatic boiler water level and make-up are provided for in the Schaub System.

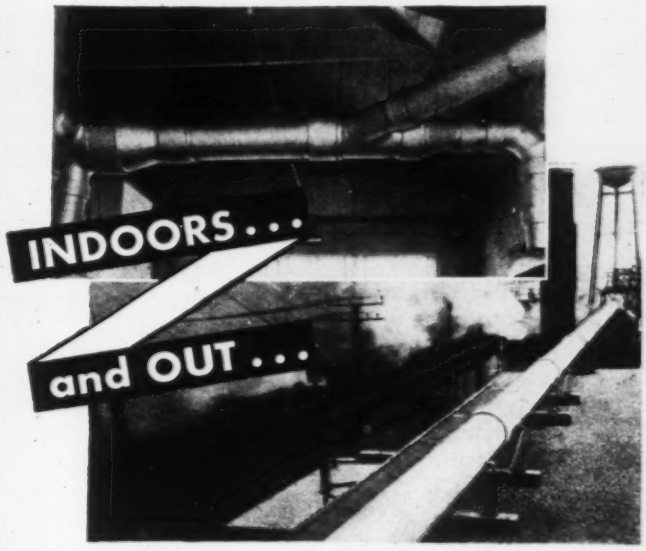


ALL of these advantages add up to the vital fact that you can get increased steaming capacity from your boiler on the same amount of fuel—or the same amount of steam on less fuel. Either way—YOU PROFIT. A Schaub System quickly pays for itself in savings of fuel, labor and maintenance.

Get full information! Write today for details.

FRED H. SCHAUB ENGINEERING CO., INC.
2116 S. Marshall Blvd., • Chicago 23, Illinois

The Key to Boiler Room Efficiency
SCHAUB SYSTEMS



Here is a duct that Fights Corrosion!

MANY USERS of ducts, vents and stacks have found, in Johns-Manville Transite Industrial Vent Pipe, a practical answer to the problem of corrosion.

Strong and durable, this asbestos-cement pipe successfully resists many of the corrosive fumes, vapors, dusts and gases encountered in industrial operations.

Transite Industrial Vent Pipe is also immune to rust, as well as highly water-resistant. It needs no painting, whether used indoors or out. It is easily installed, light in weight, and comes in a range of sizes up to 36" in diameter. A full line of Transite fittings assures corrosion-resistance throughout the system.

Data Sheet DS-336 gives full details and is free on request. Address Johns-Manville, 22 East 40th St., New York 16, N. Y.

Typical Industries in which Transite Industrial Vent Pipe is used

Aircraft	Foundry	Pulp & Paper
Automobile	Furnace	Quarrying
Baking	Furniture	Railroad
Bleaching	Gas	Rayon
Boiler Works	Glass	Refrigeration
Brewing	Laboratory	Rubber
Canning	Laundry	Shipbuilding
Ceramic	Leather	Shoe
Chemical	Match	Smelting
Dairy	Meat Packing	Soap
Drug	Metal	Soft Drink
Electrical	Mining	Sugar Refining
Explosive	Paint	Textile
Farm Machinery	Petroleum	Tool
Food	Potash	Water & Sewag

Johns-Manville TRANSITE Industrial Vent PIPE

RECENT TRADE LITERATURE

For your convenience in obtaining copies of these bulletins, see coupon on page 171. If you write direct to the manufacturer, describe carefully what literature you want, as the number given first in each item is for use only when sending requests to Heating, Piping & Air Conditioning.

Chemical and Corrosion Resistant Linings, Coatings, and Bonds

No. 6317—Neoprene, natural rubber, plastic, and combination plastic and synthetic rubber linings, coatings, and bonds, which are designed to provide protection against chemical or corrosive action, are described in a six page bulletin issued by Gates Engineering Co., P. O. Box 1711, Wilmington, Del. The company's "Gaco" products are applied to piping, valves, exhausters, many types of machinery, etc.

Condenser Tubes

No. 6318—The Wolverine Tube Div. of Calumet and Hecla Consolidated Copper Co., 1411 Central Ave., Detroit 9, Mich., has issued a booklet on condenser tubes. Included are several tables and charts giving data on safe working pressures, chemical and physical properties, dimensions, and weights for admiralty metal, copper nickel, aluminum brass, and red brass alloys. Tube sizes from 5/8 to 2 in. OD are covered. Several pages are also devoted to the "Trufin" integral finned tube.

Convectors for Steam and Hot Water Heating

No. 6319—Model A convectors for steam and hot water heating are described and illustrated in a new four page bulletin released by John J. Nesbitt, Inc., State Rd. and Rhawn St., Philadelphia 36, Pa. Dimensions and capacities are included for the various sizes of these units which consist of steel cabinets and heating elements consisting of round seamless copper tubes and flat plate type aluminum fins.

Finned Coils for Low Temperature Cooling

No. 6320—Rempe Co., 340 N. Sacramento Blvd., Chicago 12, Ill., has released a new catalog (No. 120) on finned cooling coils for use with "Freon," methyl chloride, sulphur dioxide, and ammonia. In addition to these coils, which are offered for use in walk-in coolers, display cases, etc., bare tube coils, overhead blower units, and air conditioning coils are briefly covered. In connection with the coils for low temperature cooling, prices, dimensions, capacities, and selection data are included.

Gas-Fired Boilers

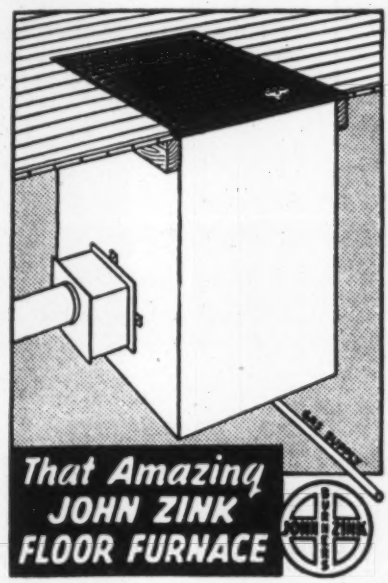
No. 6321—Three series of "Crane-Basmor" gas-fired boilers are described and illustrated in a four page folder (Producers' Council Bulletin No. 34) issued by Bastian-Morley Co., Inc., La Porte, Ind. Boiler sizes range from 52,800 to 3,840,000 Btu output and the design of the sections features a staggered heat travel.

AIR DISTRIBUTION
Is the Basis of GOOD
AIR CONDITIONING

Specify WATERLOO Registers

WATERLOO REGISTER SALES CO.
WATERLOO IOWA

It Can't Be Beat!



The floor furnace that features EFFICIENCY, QUIETNESS, DURABILITY, and ECONOMY! Due to better construction it doesn't pop or rattle when heating up or cooling off.

It is easily installed and easily cleaned from the top. All four popular sizes are reasonably priced.

●

John Zink and his engineers manufacture Gas Burners, Oil Burners, and Combination Oil and Gas Burners for: Domestic Boilers, Heating Boilers, Industrial Boilers and Power Boilers. We are willing and capable of designing and manufacturing special burners for special purposes.

Write for Literature

John Zink Company

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TULSA, OKLAHOMA

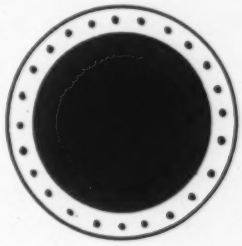
New York - Detroit - Salt Lake City - Houston - Los Angeles

No need to gasket the hole when you use Chrome Lock Rolled Gasketing. Just finger press it in place. Its adhesive back stays put when and where you want it! No lace, tie, cement or tape to bother with.

Chrome Lock Gasketing is anti-wicking—anti-corrosive. Impregnated with a chromate pigmented compound, it is flame resistant.

Chrome Lock holds up under pressure of 500 lbs. per square inch at normal temperatures. It is not effected by oil, gasoline or salt. Pliable, it holds its plasticity indefinitely. It can be laminated, or lapped.

WHY PAY FOR THE HOLE?

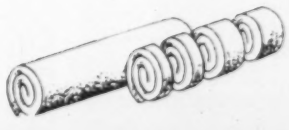


Use Chrome Lock Gasketing for piping, air conditioning, heating and refrigeration work. Write for FREE SAMPLE.

CHROME LOCK GASKETING

Available Now

Rolls Slit Rolls



Chrome Lock Gasketing

Chrome Lock

PRODUCTS RESEARCH CO.

634 S. WESTERN AVE. LOS ANGELES 5, CALIF.

ZALLEA self-equalizing Corrugated Expansion Joint installed on 100 lb. steam line at State Hospital, Norristown, Pa.

CONVERTED into years, that takes us back to 1933. That's the year the New York Giants won the World Series . . . the Chicago World's Fair opened . . . Wiley Post flew the *Winnie Mae* around the world. During that year this ZALLEA Corrugated Expansion Joint was installed—and it's still doing the same "bang-up" job *today!*

It's the quality ZALLEA builds into every expansion joint that makes them last . . . even in the severest service. There's *no* packing to deteriorate . . . *no* maintenance required. Once properly installed, they can be forgotten, with the full assurance that they will do the job intended.

Be sure! Always specify and *demand* ZALLEA Corrugated Expansion Joints.

Zallea Corrugated Expansion Joints are made in non-equalizing, self-equalizing and duo-equalizing types, depending upon the conditions under which they must operate . . . of copper, stainless steels and other corrosion-resistant alloys . . . diameters from 3" upward . . . traverses up to 7½" . . . for pressures from vacuum to 300 psi . . . for temperatures from sub-zero to 1600° F. Let us quote on your requirements.

"Code-Craft"...
ZALLEA BROTHERS & JOHNSON
...EQUIPMENT FOR THE PROCESS INDUSTRIES
816 LOCUST ST. • WILMINGTON 99, DEL.

Specify and demand ZALLEA Furnace-Annealed Expansion Joints

Generators and Motor Generator Sets

No. 6322—Construction features, applications, and available sizes of a-c generators from ½ to 150 kw, d-c generators from 50 watts to 200 kw, and an extensive line of motor generator sets are described and illustrated in a new eight page leaflet (Form 646) released by Century Electric Co., St. Louis 3, Mo.

Heating and Ventilating

No. 6323—In addition to featuring a discussion of the heating and air conditioning equipment installed in a Masonic Temple, the Vol. 10, No. 2 issue of Weather Magic, the house organ of the Trane Co., La Crosse, Wis., includes descriptions of unit heater installations in Quonset huts and in a new salt refinery. The use of the company's blowers and blast coils in dehydrating potatoes is also mentioned and a discussion of refrigeration compressor capacity control, adapted from the company's new refrigeration manual, is included.

Hydraulic Pipe Bender

No. 6324—Details of construction, capacity, features, and maintenance on the portable hydraulic pipe bender offered by Watson-Stillman Co., 140 Aldene Rd., Roselle, N. J., are contained in bulletin No. A-7, Ed. 1. The device is designed to handle standard, extra heavy, and double extra heavy steel pipe in sizes from ⅜ to 2 in. as well as standard weight pipe in 2½ and 3 in. sizes. The unit will also bend solid mild steel bars up to 2 in. in diameter.

Integral Dust Collector

No. 6325—The Aerotec Co., through its sales engineers, Thermix Engineering Co., Greenwich, Conn., has announced a new bulletin (No. 310) on an integral dust collector which is designed for grinding and buffing applications. This packaged unit, available in ratings from 300 to 2100 cfm, may also be used in conjunction with the company's electrical precipitator.

Laboratory Facilities for Testing and Research

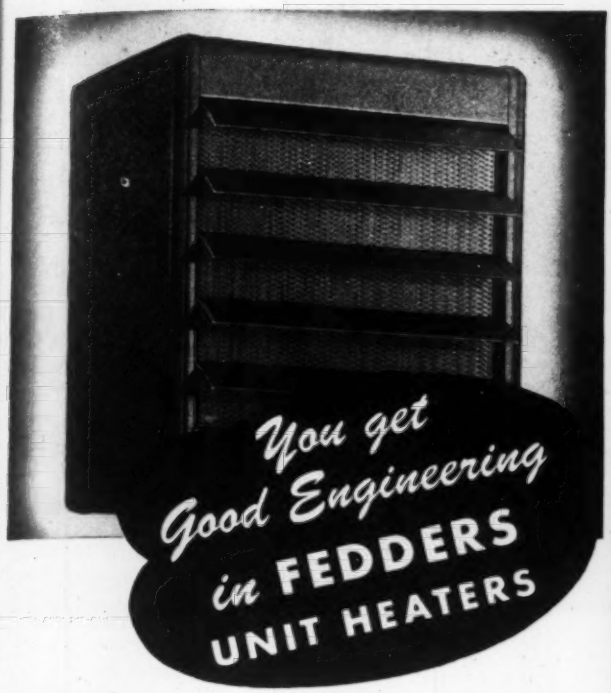
No. 6326—United States Testing Co., 1415 Park Ave., Hoboken, N. J., has released a new four page leaflet illustrating and describing the company's facilities for testing materials related to the heating, ventilating, and air conditioning industry.

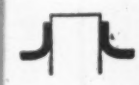
Name Plates, Panels, and Dials

No. 6327—An eight page booklet covering etched and lithographed metal instrument dials, panels, plates, scales, and gages has been published by the Premier Metal Etching Co., 21-23 44th Ave., Long Island City, N. Y. Display signs and plaques produced for many industries are also shown.

Pressure Gages

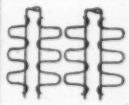
No. 6328—Gotham Instrument Co., 149 Wooster St., New York 12, N. Y., has released an eight page catalog (No. G-12) on the company's pressure gage line. Structural features, ranges of pressures, and dimensions for various instruments designed for steam, air, water, oil, ammonia and "Freon" are included. Also covered are navy type, recording pressure, and duplex gages.





Deep flanges extruded into headers give abundant tube brazing area.

Stream-lined copper tubes combine aerodynamic and heat transfer efficiency.



Individual copper fins have large-area bond to tubes Individual tubes "give" laterally to relieve expansion stresses between adjacent tubes.

Full floating element mountings relieve expansion stresses between core and cabinet.

Electrically welded cabinet provides rugged strength.

Low final temperatures for maximum comfort distribution.

Modern broad blade fans for quiet operation.

Rubber mounted motors contribute to vibrationless performance.

Made in complete line from 100 to 1,000 EDR.

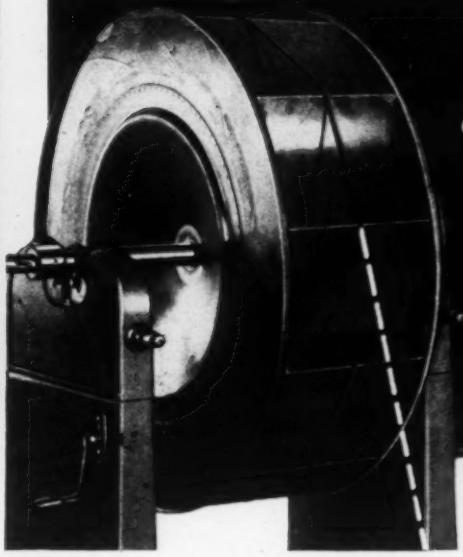
FEDDERS-QUIGAN CORPORATION

BUFFALO 7, N. Y.

Reports ILG Electric Ventilating Company:

"BEAR BALANCING

of Centrifugal Fan Wheels and Vane-Axials



① *Eliminates Vibration*

② *Increases Bearing Life"*

Your Customers...

"Notice the Difference"

...when parts are DY-NAMICALLY BALANCED

—Because the machines you build and sell perform better . . . run quieter . . . vibrate less . . . wear longer . . . require less attention—when rotating parts are Statically and Dy-Namically Balanced.

USE FAST, EASY, LOW-COST BEAR BALANCING

There's a Bear-engineered Static and Dy-Namic Balancer for each rotating part, from tiny armatures to giant turbines. For instance, Heavy Duty Model 400, shown here, is designed to handle rotating bodies ranging up to 4,000 pounds.

Whichever Bear Balancer you choose, you will get simpler operation (*any shop-hand can learn Bear-Balancing in half a day*); quicker buyer-acceptance (*Bear machines balance rotating bodies to all accepted standards*); reduced costs (*Bear-Balancer-Speed cuts per unit manufacturing costs; Bear reasonable prices cut capital investment required*). To meet and beat growing competition, send for Bear-Balancing Data Bulletin. Write today to BEAR MFG. CO. Industrial Division, Dep't HPAC, Rock Island, Illinois.

Drive Out the "Wobblies" of Static and Dy-Namic Un-Balance.

1943

BEAR

COMBINATION

STATIC AND DY-NAMIC BALANCING MACHINES

THE NEWEST CONTRIBUTION TO FASTER, LOWER COST METAL JOINING . . .

EASY-FLO 45 AND EASY-FLO 35

These new silver brazing alloys offer new low brazing temperatures and new low silver contents, features that make possible the faster production of strong, ductile, leak-tight joints and lower costs on a wide variety of metal joining operations . . . They have been created by Handy & Harman, originators of the well known silver brazing alloys, SIL-FOS and EASY-FLO. They are offered to industry now as a timely contribution to help lick two big problems — to increase production . . . and to decrease costs.

What will these New Alloys do for you?

THAT'S THE QUESTION—

You want to know if the lower flow point, lower silver content, faster spreading action and small amount of alloy required will save time and cut your costs — and how much. For a quick answer — **ask your regular supplier** for a free demonstration — or better still, place a trial order with him and put these alloys to your own tests on your own work.

HANDY & HARMAN

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Bridgeport, Conn. • Chicago, Ill. • Los Angeles, Cal. • Providence, R. I. • Toronto, Canada

Agents in Principal Cities

Process Control Instrument

No. 6329—Bulletin 381, distributed by the Foxboro Co., 106 Neponset Ave., Foxboro, Mass., describes the new Model 40 controller. Indicating types as well as single and multi-pen recorders are shown and the five types of control action available are explained.

Quick Response Air Relay

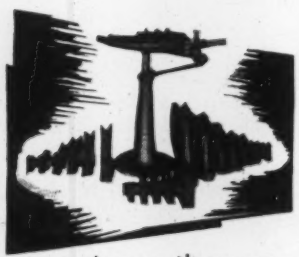
No. 6330—The Gotham Instrument Co., Inc., 149 Wooster St., New York 12, N. Y., has issued a leaflet describing the operation of the new "Proportioning-Quick Response" air relay which is designed to increase the sensitivity of the company's air-operated controls and to reduce the volume of air drawn from the compressor. It is said that the slightest change of the controlled element will bring an immediate proportionate response of the diaphragm valve regardless of the distance between the valve and the control instrument.

Radiant Panel Heating

No. 6331—A simplified, easy to read, and step by step design procedure for both floor and ceiling type radiant heating panels is contained in a new 48 page booklet offered by the National Tube Co., United States Steel Co. Subsidiary, Frick Bldg., Pittsburgh 30, Pa.

Of considerable interest and help to those not familiar with this type of heating are the simple and straightforward discussion of radiant energy and the

RADIANT HEAT PIPE BENDING is EASY, FAST with "American" MACHINES



Hand powered, the A-30 bends ½ to 2" standard pipe sizes at a radius of 5 to 1, up to 180°. Special radii can be supplied within these sizes.

Extra fast! — average bend made in 60 seconds! Versatile! — bends cold pipe, conduit and tube, copper and brass I.P.S. without crimping. Our world-wide customers include the United States Government, 9 foreign governments, and over 12,000 of the world's largest industrial plants.

Among these are:

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STATE OF VIRGINIA
E. I. DU PONT
AMERICAN VISCOSE COMPANY
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PITTSBURGH PIPE & EQUIPMENT COMPANY
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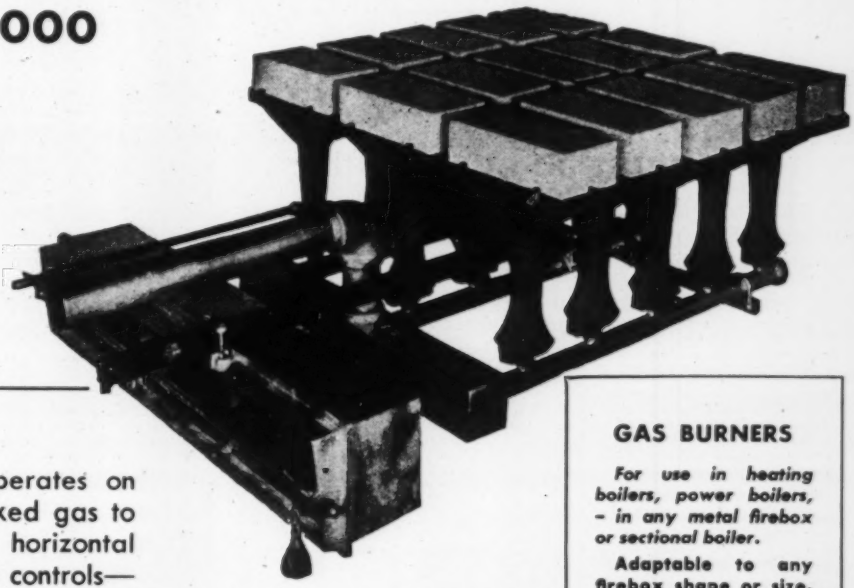
50,000 to 10,000,000 B. t. u.
WECO—N. G. E.
Series F600
GAS BURNERS



The Series F600 Burner operates on straight natural gas and mixed gas to 800 B.t.u. Gives perfect horizontal distribution. Fully automatic controls—that operate properly—can be easily applied.

Write for
F 600 Bulletin

GAS BURNERS

For use in heating boilers, power boilers, – in any metal firebox or sectional boiler.

Adaptable to any firebox shape or size.

Handles various gas pressures and affects low draft loss.

THE WEBSTER ENGINEERING CO.

TULSA —DIVISION OF— **OKLAHOMA**
Surface Combustion Corp. . . . . Toledo, Ohio

"Cash in" on pent-up demand

QUALITY IS ESSENTIAL WITH PROSPECTIVE, FINANCIALLY-ABLE BUILDERS NOW IN THE MARKET FOR MILLIONS OF HOMES

"K" fittings are carried in stock at Malleable Iron Fittings Co., Branford, Conn.; M.I.F. stocks at Kuhns Bros. Co., Dayton, Ohio.

Stock and Install....

"K" PIPE FITTINGS

For years now the American public has been saving for and dreaming of new homes. The wise plumber and contractor will see to it that quality fittings are installed in those homes.

"K" fittings are high-grade, precision-built fittings. They make up fast and pull tight. Call-backs are held to a minimum, and anticipated profits are safeguarded.

COMPLETE LINE . . . CATALOG ON REQUEST

- *Standard and extra heavy cast-iron screwed fittings.*
- *Standard flanged fittings.*
- *Standard and extra heavy companion flanges.*
- *Drainage fittings.*

STANDARDIZE ON "K" FITTINGS. ASK YOUR JOBBER.

KUHNS BROTHERS CO.
DAYTON 1, OHIO

How to STEP UP
air conditioning efficiency

Dorex Air Recovery Units increase plant capacity without increasing conditioning equipment, automatically control odors, and save power and fuel.

A great percentage of the heated, cooled, humidified and cleaned air that is ordinarily exhausted because it is stuffy, odorous or stale can be economically restored to original freshness and recirculated. This reduces the load on heating, refrigerating and humidifying equipment, lowers operating cost and expands the capacity of the system.

Nothing is added to the air. The specially processed activated carbon used in Dorex Air Recovery Equipment extracts all odorous impurities that originate from people and their habits, from tobacco smoke, food and liquor, oils and solvents. Obviously, when you remove these impurities from the indoor air, less outdoor ventilation air is needed, which materially reduces the conditioning load.

PROOF: We will be glad to send the details of typical installations or estimate on planned or existing systems. Write Dept. D6 or call our District Representative.

W. B. CONNOR ENGINEERING CORP.

AIR DIFFUSION AIR PURIFICATION AIR RECOVERY

112 East 32nd Street WB CONNOR New York 16, N. Y.

IN CANADA: Douglas Engineering Co., Ltd., 1405 Bishop St., Montreal 25, P. Q

question and answer section which deals with many of the practical considerations, both from the mechanical and economic standpoints. Numerous charts and tables covering pertinent design data are also included.

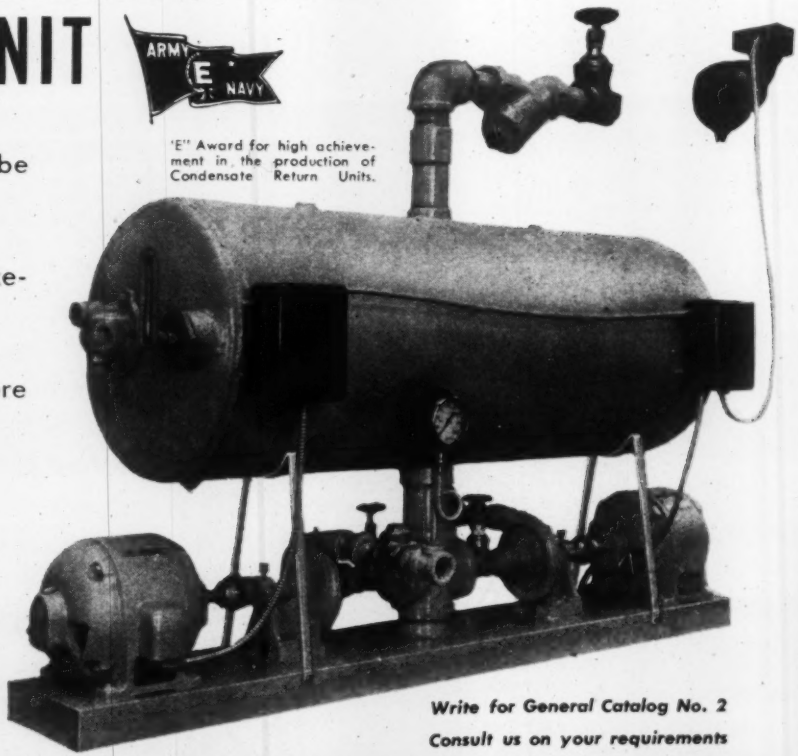
While the procedure outlined for estimating coil requirements for floor panels differs from that suggested for ceiling panels, both methods are simplified approximations which are recommended for ordinary installations, and all design procedure is based upon the papers of Dr. F. E. Giesecke, consulting engineer, professor emeritus, A & M College of Texas, and member of HPAC's board of consulting and contributing editors. The sizing of floor coils is based on the determination of required heat output per square foot of panel, which is found from the room heat loss, and the available area for the panel. Tabulated data on heat transfer per foot of pipe per degree temperature difference for various sizes and spacing of pipe is given. This data is in general agreement with that contained in the ASHVE Guide and other references. From this data the length of pipe and mean water temperatures may be calculated, or the length of pipe may be read directly from a chart. In determining water requirements, it is assumed that the temperature drop between the heating plant and the coil will be about 5 F in both the return and supply lines and it is recommended that systems be designed for a temperature drop in the coil of from 10 to 20 F. The chart for determining length of pipe directly from room heat loss, size of pipe, and temperature difference between room air and mean water temperature is based on a transmission value of 3.5 Btu per sq ft of

BOILER FEED UNIT

ARMY E NAVY

"E" Award for high achievement in the production of Condensate Return Units.

- For use where boiler feed should be controlled by boiler water level.
- Where operation of boiler water make-up condensate return is combined.
- In process steam installations where little condensate is returned.



PUMPS

This is one of the various types of Condensate Return Units manufactured by Walter H. Eagan Co. No matter what your requirements, there is an Eagan Unit to do the job.

Write for General Catalog No. 2

Consult us on your requirements

WALTER H. EAGAN CO.

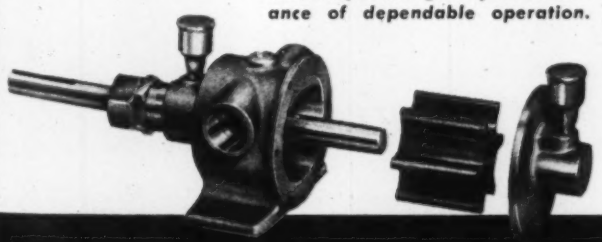
2336-38 FAIRMOUNT AVENUE, PHILADELPHIA, PA.

Are you looking for an air conditioning pump?

Here's what JABSCO has to offer!!

Jabsco – the pump with the rubber impeller – offers many practical, profitable advantages to evaporative type air conditioning applications. *It saves an electric motor* because it connects to the same shaft that drives the blower and operates ideally at blower shaft speeds! *It simplifies installation* because it requires no separate motor or wiring, mounts at any angle, and operates in either direction. *It eliminates service problems* because it is constructed of high-grade bronze with only one moving part – a tough, flexible synthetic rubber impeller. Field tested for more than five years, Jabsco Pumps are still in operation, many using the original impeller. *It is instant self-priming, water lubricated, gearless, and noiseless.* Operates at speeds from 200 to 700 r.p.m. and higher. Put Jabsco in *your* air conditioning plans. Write today for complete details. JABSCO PUMP CO., 8306 Wilshire Blvd., Beverly Hills, Calif.

This simple design is your assurance of dependable operation.



JABSCO

THE PUMP WITH THE RUBBER IMPELLER

L-H large volume of filling gives maximum retard to falling drops with minimum resistance to air-flow.

Write for Catalog 440-A

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COOLING TOWERS, INC.
Manufacturers of All Types of Water Cooling Towers
GENERAL OFFICE 4239 DUNCAN AVE., ST. LOUIS 10, MO.
PLANTS AT ST. LOUIS, MO., AND PLAINVIEW, TEXAS

external pipe surface per deg temperature difference, water and air.

In estimating ceiling panel requirements, it is recommended that the panel temperature be assumed and that the mean radiant temperature for all inside surfaces, excluding the panel be calculated. Two charts are then used for finding the heat delivered by radiation and by convection (derivation of charts discussed by Dr. Giesecke in August 1940 HPAC). The panel area is then found by dividing the total room heat loss by the panel output as determined from the charts. The required length of pipe and water temperature are determined, after the pipe size and spacing are selected, from the tabulated data on heat transfer per foot of pipe. It is assumed that 90 per cent of the heat from the ceiling panel is delivered to the room when the installation is made in accordance with recommendations contained in the manual. As a final check, the mean radiant temperature of all room surfaces is calculated and checked against the design MRT.

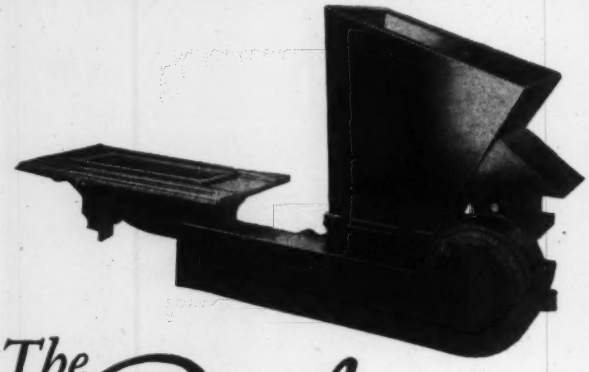
Remote Control Servo Motor

No. 6332—A two page bulletin, illustrating and describing a new 60 cycle, two phase servo motor for remote control applications, has been issued by the Transicoil Corp., 114 Worth St., New York 13, N. Y. A performance chart is included.

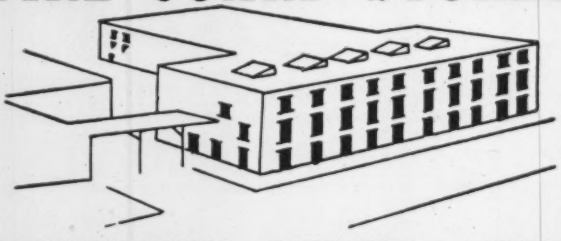
Rotating Electrical Equipment

No. 6333—Catalog No. 46-1, in eight pages and two

DESIGNED TO SELL!



The Peerless FIRE GUARD STOKER



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PEERLESS Fire Guard offers a commercial-industrial line that makes selling easy . . . The QUALITY built into this Stoker assures longer life—less maintenance and greater economy.

Peerless Fire Guard represents the ultimate in design achievement. All the wealth of Peerless 62 years' experience has been poured into this . . . the outstanding Commercial Stoker on today's market. Flawlessly engineered for TOP efficiency.

Peerless MANUFACTURING CORPORATION
INCORPORATED
LOUISVILLE, KENTUCKY
SINCE 1884

QUALITY MARTOCELLO Products are fully DEPENDABLE

ATOMIZING SPRAY NOZZLES, SPRAY POND NOZZLES, and CONDENSER WATER DISTRIBUTORS
For Vertical Shell and Tube Ammonia Condensers

ALL MARTOCELLO SPRAY NOZZLES are manufactured with precision and of a design which has been thoroughly tested for maximum results and durability. They are guaranteed to give satisfaction. Successful, efficient results depend largely upon selecting the proper number, type and size of Nozzles suitable for your installation.
THE MARTOCELLO CONDENSER WATER DISTRIBUTORS are now used as standard equipment by Progressive Refrigerating Engineers in solving their Manpower problem, because they require no attention and assure users of the lowest Condenser Operating Pressures and Minimum Power Cost.
It will pay you to consult us. WRITE or WIRE for further information.

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Serving the Ice Industry Since 1910 "There is no Substitute for MARTOCELLO QUALITY"

End CLOGGING WORRIES

on Cooling Towers and Condensing Units with . . .

SOL-VET "08"

Find Out How This Water Treatment Formula Can Remove Costly Scale and Slime In Your Equipment

● If scale, slime, rust, algae are clogging up the lines of your cooling towers, condensers and hot water heating equipment look into the advantages of SOL-VET "08". SOL-VET service, highly recommended by leading engineers, offers you the facilities of one of the best equipped water laboratories in the United States. Thorough testing of your water can help determine the right SOL-VET service formula that will prevent clogging—booster equipment capacity, save needless shutdowns for overhauling. Write today for complete data on SOL-VET service with free analysis and recommendations for your specific problems of removing scale and dirt.

Remember that if you find SOL-VET "08" is not exactly as represented—when used according to instructions, and full accurate report is given within 30 days from date of purchase—your money will be refunded in full.

GUARANTEED EFFECTIVE

If you find SOL-VET "08" not exactly as represented, when used according to instructions and full, accurate report is given within 30 days from date of purchase, your money will be refunded.

GUARANTEED HARMLESS

when used as directed, to all water conducting materials in water cooled equipment.

ANDERSON-STOLZ CORPORATION

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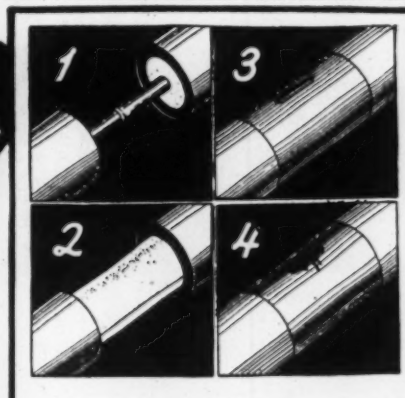
Positive Protection



4 Simple Steps

1. Field joint ready for inspection. 2. Joint covered with standard pipe insulation. 3. Durant joint casing in place ready for asphalt. 4. Asphalt poured in slot making a perfect seal.

BUILT-IN at FACTORY

For all your underground and exposed piping jobs you'll like DURANT Pre-Sealed Insulated Pipe. It is waterproof . . . reduces installation costs to a minimum . . . eliminates electrolysis and corrosion . . . requires very little trenching and field work . . . avoids extra cost of waste and breakage . . . comes to you ready to install. In short, D.I.P. is the *perfect* pipe for this type of job. Investigate D.I.P.! Write for details today.

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FOR STEAM HOT WATER REFRIGERATION

D.I.P. TRADE MARK

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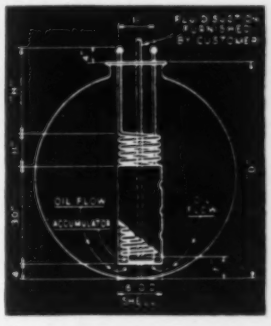
1015 Runnymede St.

Palo Alto, Calif.

The ORIGINAL Pre-sealed Insulated Pipe

Now! **Preheat Oil in Bulk Storage . . .**

REMPE "HOT-SPOT" PREHEATER



Bring Heavy Oils Up To Flow Temperature

Greater B.T.U. Value

A new tested method of preheating heavy liquids to proper flow temperature *in bulk storage* is now available with the Rempe "Hot-Spot" Preheater. An all-steel shell and coil assembly which is placed in the bulk storage tank. Suction pipes, inlet and outlet pipes for heating go through manhole cover.

EFFICIENT—POSITIVE—PREHEATING

Heats with either steam or hot water. Oil enters preheater from the bottom passes over coils into flow accumulator before entering suction line. Connections furnished for any diameter tank.

Write—wire for full details.

REMPE COMPANY

342 N. Sacramento Blvd.

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READ THESE PROFIT FORECASTS FOR A New CONCEPTION of PUMP PROGRESS!

Fully investigate the many distinct advantages Peerless Dealers enjoy in selling these 2 most advanced Domestic Water Systems. Fully supported by intensive national advertising.

PEERLESS JET SYSTEM
For deep or shallow wells. Capacities: 400 to 5,000 gals. per hour. Heads from 20 to 120 feet. Constant pressure—self priming.

PEERLESS PUMPS

PEERLESS WATER KING
For shallow wells. Capacities to 840 gals. per hour. For lifts up to 20 feet. Uses exclusive magic water lift principle. Water lubricated.

PEERLESS PUMP DIVISION
Food Machinery Corporation
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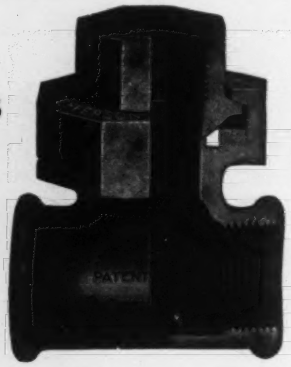
THE UNIONS WITH THE RECESSED BRASS SEAT



JEFFERSON SPECIALTY UNIONS

Effect Big Savings in Labor

Jefferson Union Tees with union on the outlet assure labor savings and better piping jobs because they take the place of an all-female union, two nipples and an ordinary tee. Three joints are thus saved. Aavilable in All-Female and Male and Female threads.
The brass seating in these and all Jefferson Specialty Unions is an exclusive feature which, located in a recess away from the runway of the fitting, leaves a straight bore assuring unrestricted flow in the pipe.

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Factories at
Lexington 73, Mass. Lockport, N. Y.

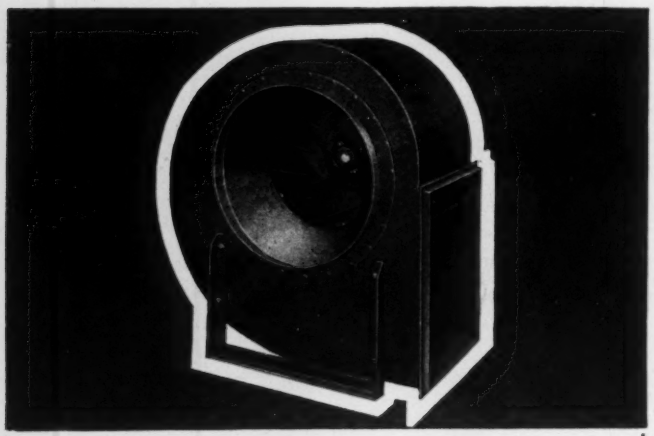
colors, describes some of the rotating electrical equipment manufactured by the Electric Specialty Co., Stamford, Conn. Numerous types of typical units are shown including a-c, d-c, and universal motors for special applications, dynamotors, converters, motor-generator sets, and gas and diesel electric generators. Since much of the company's equipment is built to specification and order, the catalog stresses the scope of manufacturing ability rather than specific models. However, general specifications included cover main construction features, uses, and the range of electrical and mechanical characteristics to which other units can be manufactured.

Self-Fluxing Solder

No. 6334—A new bulletin describing a solder product, "Tri-Core," recently developed by Alpha Metals, Inc., 359 Hudson Ave., Brooklyn 1, N.Y., has been issued by that company. The folder describes the product as a self-fluxing solder with three cores located just beneath the outer surface of the wire. This design is said to assure a continuity of flux flow, as empty flux sections are precluded, and to permit the use of lower tin content solders.

Silicone Fluids for High Vacuum Diffusion Pumps

No. 6335—Two new silicone diffusion pump fluids, DC 702 and DC 703, are said to produce a vacuum up to 5×10^{-8} and yet be able to withstand exposure to air and moisture at operating temperatures without appreciable decomposition. Offered for use in electron microscopes, metal evaporator systems, in the produc-



'GENERAL' MULTIBLADE EXHAUSTERS

Exactly adapted to the Exacting requirements of Heating, Ventilating and Air Conditioning Services

Forward and Backward Curved Blades
In all sizes, wheels 12 to 72 in.

{ And forward curve "Juniors" with wheel diameters 6 to 10 }

For your files, on request: Bulletin SC-102, with complete performance tables, dimensions, etc.—52 big pages.

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De Luxe type WK Pressure Actuated Water Regulating Valves for Freon, Sulphur or Methyl, are pilot operated, modulating. Standard adjustable opening range from 50 to 150 lbs. Factory set to open at 90 pounds. Precision engineering and individual testing for low cost, satisfactory performance. Available in sizes of ¾ to 2 inches FPT. Simple adjustment–easily serviced.

Other sizes and types are also available.

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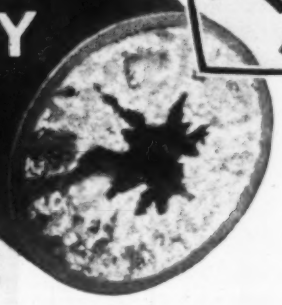
CLEAN CHEMICALLY WITH SAFETY ALL HEATING SYSTEMS



RIDAL SERVICE guarantees to remove SLUDGE and all other foreign matter from your entire plant with harmless chemicals SAFELY and economically.

RIDAL SERVICE restores to original operating efficiency your entire system—condensers, steam feed lines— condensate returns—water heaters—steam kettles—cooling and heating coils—traps, etc.

We have cleaned thousands of difficult jobs successfully and guarantee complete satisfaction.

We also sell the chemicals we use separately, without service. Get our consultation service without obligation.

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Randolph 7100 . 205 E. Wacker Dr., Chicago

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Auer makes many grille designs in stamped metals for all purposes. Furnished in sizes, materials, and finishes to fit your requirements for air conditioning, ventilating, radiator enclosure, or concealment. To simplify your specification and detail work on grilles, use the Auer Grille Catalog "G". It gives complete grille dimension tables with actual size details. A copy will come to you on request.

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NO ADJUSTMENTS NECESSARY

An exclusive patented feature is the double enclosure of glass and plastic. Another exclusive patented feature is the calibration assembly that prevents oil from seeping into the calibration dome.

Easy to install in all basement tanks, even when partially full.

Made at the factory to fit all tank sizes and according to individual specifications.

THE ONLY NON-MAGNETIC GAUGE LISTED AS STANDARD BY UNDERWRITERS LABORATORIES

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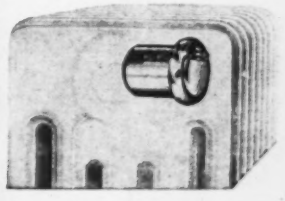
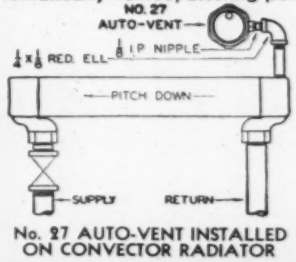


WITH THE *NEW* AUTO-VENT AIR ELIMINATOR

Install the No. 27 Auto-Vent Air Eliminator on all hot water radiators and convectors and release that invisible Air Brake that retards circulation. As air accumulates in the radiators or pipe lines it is automatically vented, assuring perfect circulation throughout the system at all times. You get more even heat and use less fuel.



No. 27 AUTO-VENT INSTALLED ON CONVECTOR RADIATOR

No. 27 can be installed on convectors, baseboard radiation panels, radiant heating coils, etc., without the use of an air chamber. For pressures up to 50 lbs.

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AUTOMATIC HUMIDIFIERS
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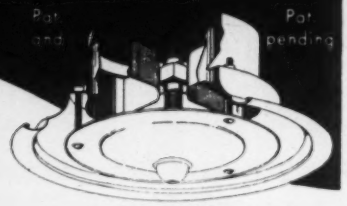
Cut installation time in half with adjustable air diffusers



Kno-Draft *Adjustable* Air Diffusers

. . . are equipped with easily regulated unit dampers for fast system balancing and an air direction adjustment for ceiling heights and individual or seasonal requirements.

Any desired condition at your fingertips

Type K Adjustable Diffuser with Type D Volume Damper
(damper regulator protected by tamper-proof cap)

Specify Kno-Draft Diffusers for better mixing of room and supply air, more uniform temperatures throughout the occupied zone and noiseless, *draftless* air distribution.

FREE HANDBOOK: Contains clear sketches, charts, dimension prints and instructive text that simplify the selection and installation of air diffusers. Please write Dept. D-4 for your copy, using your company letterhead.

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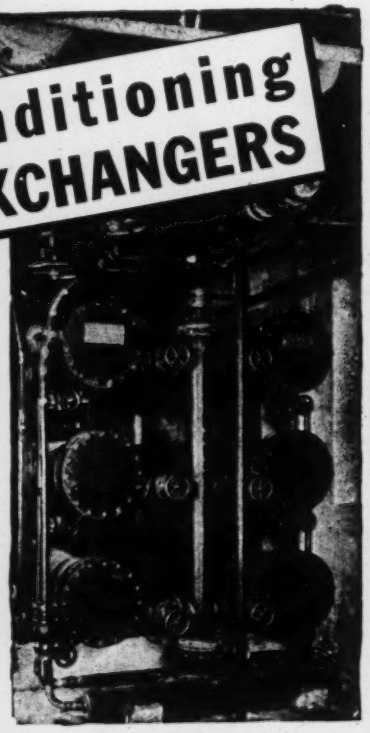
CONSECO

Air Conditioning HEAT EXCHANGERS



We design and manufacture heat exchangers for Freon and other refrigerants for refrigeration and air conditioning services. Quick deliveries. Materials available. We recently designed and built eight large Freon condensers in five days. On an urgent West Coast order we designed and built a unit in three days. Two units were built over a weekend for an emergency. Standard units in stock. For quick, economical service, write, wire or phone.

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Conseco CO_2 heat exchangers operating at 1200 psi in various Sanger chain theatres.

CONDENSER SERVICE & ENGINEERING CO., INC.

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tion of vacuum tubes, and the dehydration of foods and pharmaceuticals, these fluids are described in a new booklet (Notebook Fluid Series No. 2) released by the Dow Corning Corp., Midland, Mich.

Single Horizontal Compressors For Gas and Air

No. 6336—The 24 pages of Bulletin L-640-B1 feature the Type HB single horizontal compressors for gas and air offered by the Worthington Pump and Machinery Corp., Harrison, N. J. This well illustrated booklet, covers construction and design features, typical applications, the company's accessories such as filters, receivers, aftercoolers, and the various types of control arrangements which may be used.

Small Multi-Stage, High Pressure Centrifugal Pump

No. 6337—Catalog D-446, issued by Economy Pumps, Inc., Hamilton, Ohio, covers the Type ES small, high pressure, multi-stage pump. Designed for pressures up to 200 psi and using vertical ball bearing motors, these units are said to be ideal as boiler feed pumps in cleaning and dyeing plants, laundries and canneries, and are suitable for hydraulic press applications, fluid seals, etc. According to the manufacturer, changes in capacity cause only slight changes in pressure.

Small Scotch Marine Boiler

No. 6338—Salient features of the new "Scottie Junior" Scotch marine type boiler are covered in catalog 99d published by the Kewanee Boiler Corp., Kewanee, Ill. Available in six sizes from 6 to 30 hp and

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Rising above original estimates—
Delivering more than promised—

Coolstream Electric Water Coolers
Exceed Expectations and
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The CP-10 is delivering more than the charted 10 gallons—
The CP-10 is breaking its own record!

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THE COOLSTREAM CORPORATION
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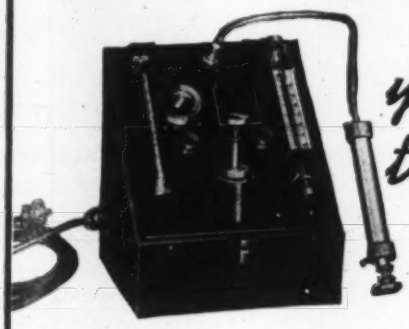
DEW POINT INDICATIONS



you can trust...

The Alnor Dew Point Indicator provides simple, rapid determinations of dew point of any non-corrosive gas. Relative humidity, grains moisture per lb., and latent heat can also be obtained by conversion factors. The consistent accuracy is due to the fact that the indication takes place in an enclosed observation chamber under controlled conditions. The end-point may be accurately observed, reducing errors due to the human element and permitting consistent results by two or more operators. Fast, easy handling encourages accurate control wherever dew point is important. This instrument is proving its value in air conditioning and refrigeration work, with controlled atmosphere furnaces, in chemical and petroleum processes, with compressed gas and gas fuel users, and similar applications. Write for Bulletin 4017.

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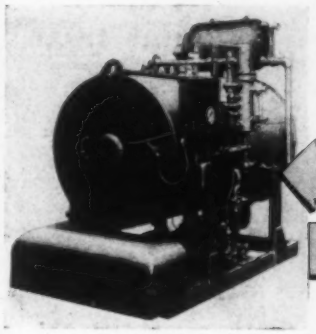
HERE'S YOUR **NEW** BOILER ROOM!



YOU'RE LOOKING AT IT IN THIS PICTURE

Just a self-contained *Steam-Pak Generator!* No massive foundations . . . no maze of pipes and connections . . . no waste space.

Simply slide in a *Steam-Pak*, make 4 simple connections, and turn the switch. Units from 15 to 100 h.p., low or high pressure, burning No. 3, 5, or 6 oils. Complete specifications are given in catalog 1D-46-7D.

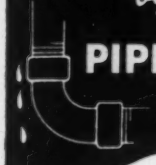
YORK STEAM-PAK GENERATOR

YORK SHIPLEY INCORPORATED

America's Most Complete Line—Industrial, Commercial, Domestic Oil-Fired Equipment

Industrial Division YORK • PENNSYLVANIA

Eliminate Costly Shut-Downs From Leaky Water Lines *by using* KEY-TITE PIPE JOINT COMPOUND



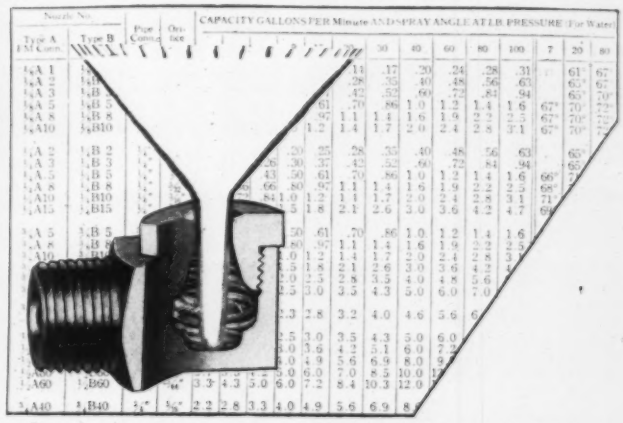
Key-Tite Pipe Joint Compound will eliminate shut-downs due to faulty connections on lines carrying water, gas, low-pressure steam, etc.

Key-Tite is economical to use because it goes several times as far as ordinary pipe dopes. Joints sealed with it will *not* leak again, yet, can be easily opened because this compound will not freeze the connections. Key-Tite does not settle in the can and always retains its plastic qualities and full body — it contains no lead nor lead substitutes and will not affect the taste or odor of potable liquids.

Send for Free Sample! Put Key-Tite to the test in actual service. We'll gladly send you a free sample.

KEY Company

4617 McCausland Ave., East St. Louis, Ill.



design and selection

These SPRAY NOZZLES offer both advantages

Write for Catalog no. 22

Spraying Systems Spray Nozzles give you two big advantages (1) outstanding design for effective, uniform spray distribution and long nozzle life and (2) wide range of types and sizes to meet exactly such specifications as spray angle, atomization, and impact. Let Catalog No. 22 prove these facts.

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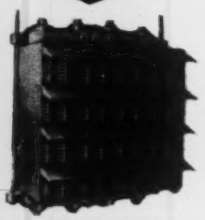
4033 West Lake Street Chicago 24, Illinois

SPECIALISTS IN SPRAY NOZZLE DESIGN AND MANUFACTURE

* One piece construction heating sections (patented) of high test cast iron that withstand steam pressures up to 250 lbs.
* No soldered, brazed, welded or expanded connections to become loose or develop leaks.
* No electrolysis to cause corrosion, breakdowns, leaks, or heating failures.

HIGH TEST CAST IRON HEATING SECTIONS



IT'S the material that makes the difference. GRID High Test Cast Iron Unit Heaters are built to last for years—to last as long as the pipes furnishing steam to them. In many plant installations they have been operating for 16 years without maintenance.

Complete details upon request.

SEND! *for free booklet "Corrosion in Unit Heaters"*

D. J. MURRAY MANUFACTURING CO. WAUSAU WISCONSIN

designed for 100 psi working pressure, the boiler is said to be portable and is of the horizontal return fire tube construction.

Summer Air Conditioning Room Type Packaged Unit

No. 6339—Bulletin 901, released by the Remington Air Conditioning Co., 44 Beaver St., New York City, describes the company's Model 90 room type air conditioning unit which is designed to cool, dehumidify, circulate, and add fresh air to rooms in homes, offices, shops, etc. The 7/8 hp compressor-condenser unit may be obtained either for air cooled or water cooled use.

The Use of Resilient Flooring Materials with Radiant Heating

No. 6340—Test results on the effects of different panel temperatures, from radiant heating floor panels, on various types of the company's resilient tile flooring materials are briefly described in a two page leaflet (Producers' Council Bulletin No. 50) issued by the Armstrong Cork Co., 4400 Concord St., Lancaster, Pa. Also included are recommendations as to the proper type of flooring material for various types of radiant panel construction.

Tube End Forming

No. 6341—A line of machinery, built for the purpose of forming and shaping the ends of tubing to close tolerances, is described and illustrated in bulletin No. G-1 which has been issued by the Vaill Engineering Co., 17 Brown St., Waterbury 89, Conn. Illustrations of many tube ends and shapes are used to emphasize

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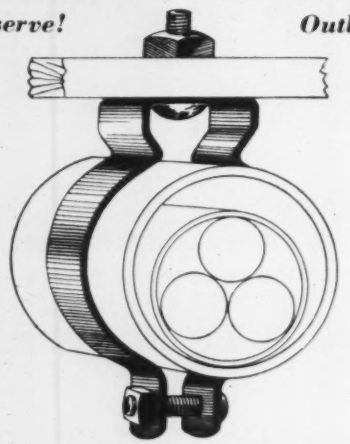
Steel HANGERS, CLIPS, STRAPS

Outserve! *Outlast!*



MINERALLAC Cable, Conduit and Messenger Hangers are STEEL. Easier, quicker to install; permit speedy, compact wiring; economical. Also in Everdur . . . Porcelain Insulating Bushings available.

Jiffy STEEL Clips (Pipe-clamp) require only one screw, nail or bolt; rib-strengthened; for hanging pipe, conduit, BX cable, mounting coils, etc. Millions in use.

Steel Straps for Messenger-cable services on outlet boxes; may be used in conjunction with hangers.

Order from your Electrical Wholesaler. Send for literature.

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WATER HEATER TOPS
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RANGE BOILER HEADS AND BOTTOMS
TANK HEADS

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THE COMMERCIAL SHEARING AND STAMPING COMPANY.

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Better AIR CONDITIONING *at Lower Cost*

GOVERNAIR
AIR CONDITIONING SYSTEMS

Here's what Governair Air Conditioning Systems offer you:

1. Complete, self-contained unit assemblies for greater operating efficiency.
2. Cools . . . Dehumidifies . . . Cleans . . . and distributes air.
3. Easier to Install . . . all internal wiring and piping incorporated in unit.
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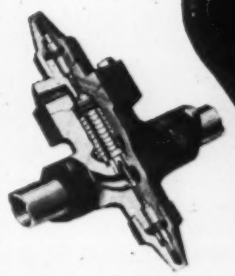
6. Compact . . . simplified design takes minimum space.

GOVERNAIR Self-contained Units are available in a wide range of sizes, enabling you to secure a system that is tailor-made to suit every special requirement.

Manufactured by the pioneers of completely self-contained air conditioning units

GOVERNAIR CORPORATION
Oklahoma City, Okla.



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Another Phillips Product

. . . PILOT OPERATED LIQUID CONTROL VALVE

May be piloted by either float, thermal or electric valve.

The recognized higher efficiency rate of a flooded operated evaporator in a refrigerating or air conditioning system is further emphasized when the evaporator is used in conjunction with Phillips Float Controls. Maximum B. T. U. transfer is assured. These controls respond so instantly to any wide variations in load that their use is indicated on practically all installations. Available capacities: "Freon" 20 to 500 tons; ammonia, 1 to 2000 tons. For high or low side applications. Write for NEW Bulletin.

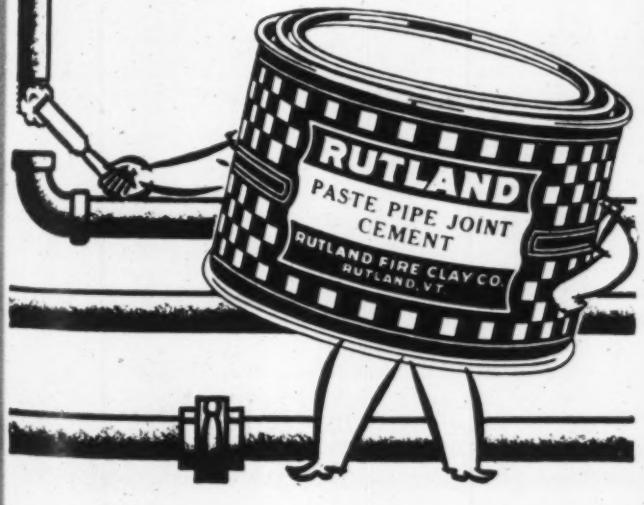
The Home of Phillips Regulating Valves and Float Controls
Established in 1929

H. A. PHILLIPS & COMPANY
2255 W. CARROLL AVE., CHICAGO, ILLINOIS

The No-Stain Pipe Joint Cement

Using Rutland Pipe Joint Cement saves a lot of cleaning up afterwards. It does not stain hands or fixtures. Also, Rutland seals joints tightly and lasts indefinitely —but always leaves pipes easy to disjoin. Remains soft in can.

Mail post card for free sample. Rutland Fire Clay Company, Department H-36, Rutland, Vt. Also makers of Rutland Retort Cement, Furnace Cement, Asphalt Paint, Concrete Patcher.



ASK for a Copy *Just off the Press*

This Bulletin No. 461, gives an up-to-date description of Therm-O-Tile Underground Pipe Conduit and its numerous advantages.

Write for your copy.

THERM-O-TILE
Reg. U. S. Pat. Off.

More for your money. Insulation always dry. Efficiency permanently high. Grades permanently maintained. "Spread footing" foundation. Stronger. First cost is competitive. Lowest final cost, etc. *Sold and installed by Johns-Manville Construction Units in all principal cities.*

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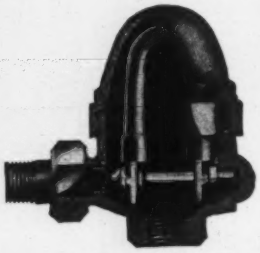
ACCURATE PERFORMANCE ALWAYS
—because they're designed for the job!

HAINES TRAPS

F & T Trap



Vento Radiator Trap

Accurate performance is a byword when you install Haines Traps. The Float and Thermostatic Traps are designed for any low pressure job up to 20 lbs. in the ¾" size and 30 lbs. in the 1" and 1¼" sizes; they cannot become air bound, and the Haines underslung valve principle assures safety—no danger of building up a pressure.

Haines Traps have the famous Bourdon Thermostatic Tube as the operating member. It's the strongest ever built into a steam trap. Since the Bourdon Tube is used where accuracy is paramount it follows that accuracy is an integral part of any Haines Trap.

They're built for easy inspection, too. Even under pressure you just remove the cover and all the working parts are before you.

Write for details now.

WM. S. HAINES & CO.
460 N. 12th Street **Philadelphia 23**

the versatility of the equipment. Design features are enumerated and suggestions for simplifying product design are included.

Underground Pipe Conduit

No. 6342—A four page, two color bulletin (No. 461) on "Therm-O-Tile" conduit for underground pipe lines has been issued by H. W. Porter & Co., 825 Frelinghuysen Ave., Newark, N. J. Features, advantages and installation specifications are given for this salt glazed semi-circular, air cell tile which is supported on tile blocks.

Vertical Centrifugal Pump

No. 6343—A six page bulletin (No. B-137) describing the design, construction, and application of three types of vertical centrifugal pumps has been issued by the Peerless Pump Div., Food Machinery Corp., 301 West Ave. 26, Los Angeles 31, Calif. Designed for a wide variety of industrial services such as sump and drainage pumping, general water supply, cooling tower service, etc., these units include both submerged and close-coupled types and may be adapted to all forms of power drive. In general, all three types develop capacities from 200 to 5000 gpm and will pump at heads from 20 to 100 ft.

Vertical Motors

No. 6344—Protected type motors, designed for close coupling to centrifugal pumps, agitators, atomizers, and many types of machine tools, are described in bulletin SL-300-3 issued by the Crocker-Wheeler Electric Mfg. Co., Div. of Joshua Hendy Iron Works, Ampere 14, N. J.

Manufacturers of **INDUSTRIAL INDICATING, REMOTE READING and RECORDING THERMOMETERS**

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CONTROLLERS for Time, Pressure and Temperature

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PRESSURE GAUGES and RECORDERS

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A lot of HEAT in a small package

CHROMALOX *Electric*
CIRCULATION HEATERS

FOR HEATING WATER · PRE-HEATING
FUEL OILS · SUPER-HEATING STEAM

CHROMALOX Electric Circulation Heaters are used as water heaters for connecting to tanks and kettles. They are used to pre-heat low grade fuel oils, heat oil-jacketed processing equipment and super-heat steam. Manual control or automatic thermostats assure accurate temperatures. Installation and operation costs are low. Capacities from 1-KW to 15-KW.

CHROMALOX Application Engineers will be glad to show you how these Circulation Heaters and other CHROMALOX Electric Heaters can do many heating jobs more efficiently and more economically.

FOR MORE DATA, request Catalog 42 and "100 Ways to Apply Electric Heat" Booklet.

EDWIN L. WIEGAND CO., 7610 THOMAS BLVD., PITTSBURGH 8, PA.

CHROMALOX SB-1

ELECTRIC HEATING AT ITS BEST!

CARRIES HEAVY OVERLOAD

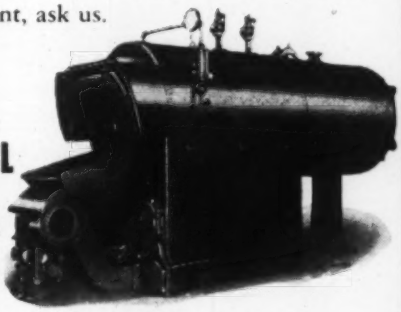
One of our customers writes thus:

"When we erected our new building in 1937, we installed a Brownell Matched Unit consisting of a No. RM-212A Boiler and a 5½ x 5¼-ft. L.S.R. Stoker.

"Both Brownell boiler and stoker have given us excellent service, operating continuously since first installed even though, due to greatly increased business, the unit has been very much overloaded the past few years."

That's the kind of service which has built up Brownell's 92-year-old reputation for making good equipment. If you don't know the name of our nearest agent, ask us.

THE
BROWNELL
COMPANY
408 N. FINDLAY ST.
DAYTON 1, OHIO



BROWNELL MATCHED UNIT

Just use it once—

The Alnor Velometer

gives you instantaneous, direct readings of air velocity in feet per minute. Hold it in the air stream for low range readings; use the tube-connected special jets for high range readings or inaccessible locations. That's all there is to it, and once you use the Alnor Velometer you will never tolerate other methods.

The Alnor Velometer is built in several standard ranges from 20 fpm to 6,000 fpm, and up to 3 inches static or total pressure. Special ranges available as low as 10 fpm, and up to 25,000 fpm and 20 inches pressure. Write for Velometer bulletin.

ILLINOIS TESTING LABORATORIES, INC.
420 NORTH LA SALLE STREET
CHICAGO 10, ILLINOIS

Statement of Ownership and Management of HEATING, PIPING & AIR CONDITIONING for October 1, 1946

The following is a statement of ownership, management, etc., as required by the Acts of Congress of August 24, 1912, and March 3, 1933, of Heating, Piping & Air Conditioning, published monthly at Chicago, Ill., for October 1, 1946:

State of Illinois, County of Cook, ss.: Before me, a Notary Public in and for the State and county aforesaid, personally appeared F. P. Keeney, who, having been duly sworn according to law, deposes and says that he is the Publisher of Heating, Piping & Air Conditioning, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business manager are:

Publisher, F. P. Keeney, Chicago, Illinois.
Editor, C. M. Burnam, Jr., Chicago, Illinois.
Managing Editor, C. M. Burnam, Jr., Chicago, Illinois.
Business Manager, Chas. E. Price, Chicago, Illinois.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)

Keeney Publishing Company, 6 North Michigan Avenue, Chicago 2, Illinois. Stockholders: F. P. Keeney, Chicago, Illinois; W. J. Osborn, Fairfield, Conn.; Chas. E. Price, Chicago, Illinois; Robert A. Jack, Cleveland Heights, Ohio.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

F. P. Keeney, Publisher.

Sworn to and subscribed before me this 23rd day of September, 1946.
Grace E. Waymire.

(SEAL) [My commission expires February 10, 1950]

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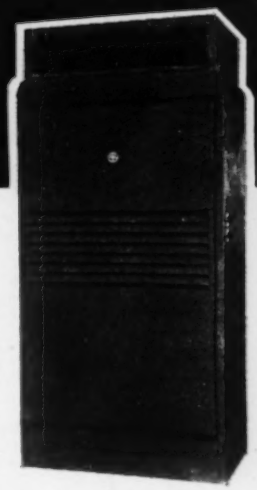

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